THE
TROPICAL AGRICULTURIST:
JOURNAL OF THE
CEYLON AGRICULTURAL SOCIETY.

VOL. LII. PERADENIYA, JUNE, 1919. No. 6.

SUPPLIES OF SEED PADDY.

In view of the shortage of rice in the Colony at the present time and the consequent high prices ruling for paddy, it is essential that some thought should be given to the reservation of stocks of seed paddy for the next sowing season.

In certain parts of Uva, there was actually a shortage of seed for sowing for the last crop, and the Chief Headmen had to take steps to secure seed for loan to the village cultivators. The villagers owing to scarcity and high prices had been obliged to consume the whole of their stocks, and had no provision for seed for the next sowing.

What has occurred in one locality may equally well occur in others, and therefore it seems essential that steps should be taken at an early date to see that adequate reserves are kept in stock in every village. Holders of paddy may be tempted, owing to the high prices prevailing, to sell the whole of their stocks or they may, particularly in the poorer districts, be tempted to consume their whole supplies.

Every village should therefore take stock, and undertake that adequate reserves are in sight for the next sowing season.

The importance of this question has been impressed upon all members of Co-operative Credit Societies assembled during the past two months for general annual meetings, and a circular printed at the end of this article, has been distributed in the

Vernaculars by authority of Government to all Food Production Committees for circulation amongst agriculturists.

All Agricultural Instructors have been informed of the importance of impressing upon cultivators, the absolute necessity of having adequate stocks in hand.

One Co-operative Credit Society in the Northern Province has made arrangements for the collection and storage of seed paddy for distribution to its members, when the next sowing season arrives. Other Societies may follow this example particularly in those areas where only one crop can be raised per annum.

There are evidences in every district of the Colony that increased attention is being given to paddy cultivation. The high prices have induced many cultivators to pay attention to lands which have been idle for some time. The efforts of Revenue Officers and their Headmen, as also the efforts of Food Production Committees, are beginning to result in greater attention to cultivation. It is true that there have been many disappointments, and influenza has been responsible for many fields not having received attention. But progress has been made.

There is no doubt, however, that preparations must now be begun for the next North-East or *Maha* season. A general campaign throughout the whole country for greater sowing and planting during the next season should be started without delay and provision made that there will be adequate stocks of seed on hand. Food Production Committees can do much in this direction. Much has been accomplished in the past, but greater efforts in the future are essential.

Agriculturists throughout every district must realize that upon their efforts depend the welfare of the Colony. All and everyone should plant somethng and every assistance possible will be given to cultivators by Agricultural Officers to further the production of greater quantities of foodstuffs in the Colony.

In this issue is included the address made by HIS EXCELLENCY THE GOVERNOR to the Ratnapura Co-operative Credit Society. This statement clearly indicates the position in regard to the "Food Situation." It has been printed in the Vernaculars and distributed throughout the Colony.

There is no doubt that the situation at present demands the combined efforts of all, and it appears to be most essential that the importance of having adequate stocks of seed paddy available for the next sowing should not be lost sight of.

Food Production Circular No. 1.

SEED PADDY FOR NEXT SEASON.

It is essential that the attention of all cultivators should be directed at the present moment to the absolute necessity of saving sufficient seed paddy for the next main sowing season. There is a danger that with high prices for paddy, cultivators may be tempted to eat or to dispose of the whole of their stocks, taking no thought of the next season.

It is the object of this Circular to impress upon all, the absolute necessity of a sufficient stock of grain, being reserved for the next sowing season. Every Village Committee should see that sufficient stocks are visible. Every landowner, middleman, and cultivator should feel that he has a duty to see that there is seed grain available for sowing all his lands. Now is the time to take stock and to decide upon what quantity must be reserved.

It is not advisable in the present state of our knowledge to move seed paddy from one district to another, except on an experimental scale. Soil and climate have such influences upon varieties of paddy, that it is more than probable that there are large numbers of names of paddies in different districts relating to one real botanical variety. Trials to move seed paddy from one district to another have not been wholly successful. There have been some complete failures.

It therefore seems essential that every Headman's Division should reserve its own seed supply of those varieties that are usually grown in the Division.

In case it becomes necessary to secure seed paddy from another district, the Department of Agriculture should be consulted.

Department of Agriculture,
May 15th, 1919.

FOODSTUFFS.

THE IMPORTANCE OF GREATER LOCAL PRODUCTION OF FOODSTUFFS.

The following extracts from the opening address given by HIS EXCELLENCY THE GOVERNOR at the Annual General Meeting of the Ratnapura Co-operative Credit Society are published for general information and guidance. In these extracts is emphasized the urgent necessity of a greater production of foodstuffs in the Island, and the need for cultivators to make great efforts in this matter at the present time :—

"As you are aware, from the earliest date of my Administration in this Colony, I have been trying to impress upon the people, and the villagers particularly, the necessity of increasing the production of foodstuffs. At the present moment this country imports something in the neighbourhood of 360,000 tons of rice yearly. It imports the greater part of its curry ingredients, and large quantities of other foodstuffs, such as dhall, all of which can easily be grown in this Island. In these days following the war, as you are all aware, the conditions of the world are generally in an abnormal state. Large areas of land in the countries of Europe which produced more food than was necessary to meet their own requirements are at the present day growing nothing. The result is that for another year or two the demand for foodstuffs for the proper feeding of the peoples of Europe will be difficult to meet, if it can be met at all. As you are aware, during the past year a drought has occurred in India, and a large number of the poor people have been cast upon the famine relief funds. The famine conditions in India necessitate the importation to India of large supplies of rice from Burma and the use of all she grows. In ordinary times there is a surplus available for feeding you and other places.

"The conditions are plainly serious in this country. If the next Monsoon falls—and we hope it may not—the conditions will be very serious. The exportation of rice from India and Burma to Ceylon will be greatly reduced. These conditions which I set before you are the conditions of to-day. At any time similar conditions may exist, even in ten or twenty years' time. You are now threatened with the possibility of your supply of rice from other countries being cut off, and having to depend on what you grow in your own land. This is only one side of the question. The other side is this: Why should you be sending your money to India

and Burma when rice can be grown here as well as in Burma, and curry ingredients can be grown here as well as in India and elsewhere ? I cannot understand why the cultivator here should not grow enough for himself, and a surplus to feed those in towns depending on shops, boutiques or kaddies, for their foodstuffs. If under such conditions it were possible here to grow paddy, and ingredients for curries their prices will be lowered to the consumer. Also, the village agriculturist, instead of being the poor man, will be not wealthy perhaps, but in a condition better than at present.

" You will keep your money in the country and not send it to India and Burma as you do to-day. I am proposing with the help of the Director of Agriculture to largely increase the Staff of Agricultural Instructors. I have known in many other places the considerable difficulty experienced in trying to teach those who think they know better the more scientific methods of producing crops. The cultivation of foodstuffs as practised by your fathers, your grandfathers, and great-grandfathers produced crops such as satisfied you. If you will listen to the instructions given, and if you follow them out, your food crops will increase. Instead of only producing sufficient quantities for yourself, you will have enough to sell, and have money in your pockets, which you do not possess probably at present. There is a certain conservatism, a desire of sticking to old methods, that you think are best, and it is difficult to undo this conservatism. I will try to impress on you that the methods, though they were followed by your fathers and grandfathers, are not good. You require to be much more careful with your fields ; you require to take the advice given to you ; you require to take trouble in the selection of your seed ; and you require to manure your fields. I believe myself that the results of such endeavours will mean the studying and using of improved methods of cultivation. A certain number of you will have to take up the new ideas, and Western ideas of scientific agriculture are better than yours. One man following the instructions and producing crops of superior quality and larger crops will be what we call an object lesson. He will be asked by others : ' How is it you have improved your crops and are able to cultivate more paddy ? ' He would say, if he spoke honestly, that it was by following the instructions given to him by the Agricultural Department.

" He will be the object lesson of the district where he lives. If any one desires to be such an object lesson, let me urge him to discover the right thing to do, and ask the assistance of the Agricultural Department, which will be given to him willingly."

THE SWEET POTATO.

Of the several foodcrops recommended to be extensively grown to meet a possible shortage of food, sweet potato is about the most well-known and most popular crop. It is already fairly extensively grown in the villages, but not so on estate cooly gardens. The object of this article is to encourage its cultivation on an extended scale both in estate gardens and villages.

Sweet potato is accepted to be a nutritious food. It is easily cultivated. It is a quick-grower, yielding large crops—10 to 12,000 lb. per acre. In Ceylon it can be cultivated anywhere. It is a pretty hard crop, less subject to disease than many a crop. Being appreciated by all classes, there is a ready sale. At the present time a pound is sold at five cents in the Kandy market. It is eaten in a variety of ways. It is boiled and sold in the streets. Is cooked as a curry in several forms. Sliced and dried, it can be preserved for months together. It even has taken the place of English potato.

There are several varieties, and recently several excellent varieties have been introduced from Mauritius. The most extensively grown varieties are the white and red-coloured potatos. The cluster sweet potato, also introduced not very long ago is quickly replacing the common varieties. Those who are trying sweet potatos as a new crop should obtain cuttings of the Mauritius varieties or the cluster variety.

The best soil for the crop is a light sandy or loose loam. Clay, stiff and wet soils are unsuitable. Very rich soils are inclined to produce a large quantity of vines and leaf.

The land for sweet potatos must be worked fairly deep. The deeper it is worked the larger the out-turn. Though hardly any special manuring is necessary, a free application of well-rotted cattle manure will be very beneficial. If sweet potatos are grown on land heavily manured for the previous crop, it is all the better.

Propagation is usually by cuttings. These should be 9 to 10 inches long and buried rather deep in the soil. The best time to plant is with the early rains. If cuttings are not available, plant a few tubers of a medium size and of a short compact shape. These will send up shoots from which cuttings can be taken to start a plantation.

Cuttings are better planted on ridges, raised about 9 inches high and about a foot broad. The ridges should be at distances of 2 feet apart. Cuttings should be put at a distances of 10 to 12 inches, and the soil well firmed around the cuttings.

The cuttings will strike root easily in about a week and after that the growth will be vigorous. If planting has to be done in dry weather, it will be found advantageous to dip the cuttings in a thick paste of fresh cow-dung and soil, and after planting, it will be necessary to water for a day or two.

When the plants have begun to grow, very little attention is necessary. The ridges should be kept free of weeds.

The crop is ready for harvesting when the leaves begin to turn yellow. There are early and late varieties. Some take 3 months others 4, and some varieties even 6 months. Before raising the crop, cut away all the vines and lift the potatos by digging them out.

The crop can be kept for some time by adopting the following method of preserving: Put down a thick layer of dry sand and place a layer of tubers, then run in sand until all the crevices are filled in and the tubers are covered. Keep another layer and repeat the process until as often as tubers are kept. Cover the whole with some straw or dry material.

W. MOLEGODE, S.A.I.

TOMATO GROWING.

The Tomato is one of the most popular vegetables with all classes and sells readily; fetching at times very good prices—20 to 25 cents per lb. It is a quick-yielding vegetable—the fruit beginning to ripen in about 10 weeks. It can be very extensively grown in Ceylon being suited to all elevations. Excellent tomatos have been grown in the Residency Gardens at Puttalam by MRS. W. E. WAIT—perhaps one of the worst places in the Island, where conditions for vegetable growing are far from favourable. Badulla is famous for tomatos, and the largest specimens I have seen, were produced here. A large quantity is also grown in Dumbara and Hewaheta. At the recent village shows in Matale district there were exhibited some very good fruit locally grown. But such a popular vegetable that is always in demand is not grown sufficiently extensively in Ceylon, nor do the village cultivators pay attention to improving the varieties commonly grown.

VARIETIES.

Cultivators should aim at producing fruit of medium size, well shaped and with a smooth skin. There are a large number of varieties to select from, but I have found Brunning's "Large Red" and "Chalk's—Early Jewel" to be suitable and popular.

SOIL.

Almost any kind of soil, provided it is well drained, can be made to grow tomatos. Low wet soils should be avoided, and where it is available a loose mellow soil with a fair proportion of sand should be selected as being about the most suited soil.

PREPARATION OF LAND AND MANURE.

The ground should be well prepared, dug fairly deep and all weeds and vegetable matter turned under the surface and the soil reduced to as fine a tilth as possible. If the soil is rather stiff, it can be improved by adding some sand. Well-rotted farm-yard manure with some lime added to it, will give good results.

PROPAGATION AND NURSERY BEDS.

Propagation is by seed. ½-lb. of seed will give more than sufficient number of seedlings to plant an acre. Raise seedlings in nursery beds, or if in small quantity, in boxes. The soil for the nurseries should be made very fine, loose and mellow for a depth of about 5 to 6 inches. A dressing of well-rotted cattle or horse manure mixed with lime should be thoroughly incooperated into the soil.

The seed should be sown thinly in drills, 3 inches apart and watered and shaded carefully. Heavy watering and a crowded seed-bed will effect the seedling and kill many of them.

PLANTING

Tomatos should be planted in rows or preferably on ridges, 4 feet apart and the distance in the rows should be about 3 feet. Only good healthy seedlings should be transplanted, and the soil made firm around the plants. After transplanting, water thoroughly, if in dry weather, shade for 2 or 3 days. After the plants have stuck root, remove the shade.

AFTER CULTIVATION

Tomatos are either run on trellis placed 3 or 4 feet above ground or are tied to poles about 6 feet high firmly fixed close to the plant. A good thing is to erect an arbour over the space left between the rows and train the plants on to them. Nip out the side branches or offshoots until the plants have well set on the trellis, or have reached the top of the poles. In the latter case when the plants have reached the top, nip off the last bud and allow offshoots to grow.

When carrying a heavy crop, it will be well to mulch around the roots. Weed and hoe the soil frequently and water when necessary.

HARVESTING.

Those who are accustomed to visit the Kandy market on Friday morning would have observed that practically all the tomatos that come in are too green. Tomatos picked green never ripen sufficiently or satisfactorily, to be fit for eating. Nor should fruit be allowed too long on the trees to ripen because transport of fully-ripe tomatos result in the greater number of them being spoilt. The proper time to pick is when the fruit have reached full maturity and begin to change from green colour to the white stage of ripeness. In plucking the larger fruit take them off with a bit of stalk attached.

SEED.

Leave the best fruit for seed. The seed is obtained by washing it out in a basin. Spread out the seed to dry and keep in a cool, dry place in an airtight bottle until required.

DISEASES.

The sleepy disease or the droop or wilt disease is very common in tomato. The roots are first attacked and then the leaves begin to droop and the plants die. As soon as the disease appears, all diseased plants should be removed and burnt. Plenty of lime should be applied to the soil, and do not attempt to grow tomatos in the same soil for some years.

Tomatos if grown two or three years in the same land, soon deteriorate and becomes easily liable to disease.

W. MOLEGODE, S.A.I.

PLANTAIN FLOUR.

At the Rambukkana Agricultural Show exhibits were made of plantain flour. These were interesting exhibits, and the product was well prepared. Awards were made to those exhibits, but they do not appear to have attracted the attention they deserved from the general public. In the West Indies during the scarcity of foodstuffs, considerable use has been made of plantain flour as a substitute for wheat flour. Plantain flour is very digestible and nutritious. The directions for its preparation issued in the TRINIDAD GOVERNMENT GAZETTE in February 1918 were as follows :—

"Any kind of plantain is suitable. Cut the bunch when it is about three quarters full. Peel the plantains and slice them with a nickel or bamboo knife (do not use steel knives), spread the sliced bananas thinly on wooden trays in the sun to dry. In fine weather they will dry in 2–3 days. When dry, crush in an ordinary maize grinding mill or pound in a mortar. Sift through fine mesh."

The following extract from the BULLETIN OF THE DEPARTMENT OF AGRICULTURE TRINIDAD & TOBAGO, Vol. XVI., No. 2, should also be of interest:—

[*Notes on the Preparation of Flour Substitutes, by R. O. Williams, Curator Royal Botanic Gardens and St. Clair Experiment Station, Trinidad.*

PLANTAIN FLOUR.

As a substitute for wheaten flour, plantain flour is probably one that will be made the greatest use of as it is the cheapest to produce. We have also a number of other starchy foods that can be used, some of which will be described in detail.

Plantain flour can be made from any kind of plantain, although it is generally recommended to use those plantains such as the "Red fig" which at the present time are scarcely used at all in Trinidad. On some large estates quantities of this plantain can be seen. From a bunch of silk figs the hands were cut off and weighed; they yielded 26·19 per cent. of flour.

When cutting the plantains, it is better to cut them before they are quite full than to leave them till they are beginning to ripen, as if too full, they will, after slicing, ripen in the sun, be very difficult to dry and produce a sweet flour. The process of pealing and slicing is a simple one, and can be done most economically by boy labour, the boys becoming quite expert and performing the work quickly and well after a few bunches have been done. Steel knives should not be used on the green fruit as they blacken them unless immersed under water the whole time. A nickel or fruit knife is the best tool to use.

When slicing the plantains the thinner they can be cut the better, as it is essential for them to dry quickly. In the dry season no trouble is experienced, and they will dry thoroughly in a couple of days if spread on wooden trays in the blazing sun. In the rainy season it is a different matter and it is best to choose a fine morning for the work, and if a shower comes on remove them to a dry warm room. A drying room with hot air going through it would be necessary on a large scale, but when doing a few bunches for the home, this is not needed as they can always be dried in trays on a warm grate. As soon as the chips are dry they are ready for milling. On a small scale they may be pounded, grated, or better still ground in an ordinary corn-mill which can be bought from about $2, upward. After buying the plantains and paying for the labour, the flour can be produced for about three cents a pound; therefore for those who grow their own plaintains and use their own labour, the cost is practically *nil*.

The uses of plantain flour are many and varied: It would be as well here to mention that as a food substitute plantain flour is most valuable, it being very digestible; so much so, in fact, that well-known medical authorities have recommended its use for the feeding of children and invalids; we need therefore have no fear of bad consequences to our health by using plantain flour.

Plantain bread is best made from a mixture of wheaten flour and plantain flour, but in what proportion is a question for the consumer to judge for himself. Personally, I use it and find it very wholesome, mixed in the proportion of two parts plantain flour to one of wheat flour, other people may prefer it half and half, or one-part of plantain flour to two of wheat flour. The bread is dark in colour, or lighter according to the amount of wheat flour added, this probably being the only reason why some people prefer the addition of wheat flour in large proportions. The addition of a certain proportion of wheat flour is necessary to give the bread the proper consistency.

The making of bread can easily be done by the house-wife. Occasionally for some reason a little difficulty is found in getting the plantain flour to rise, when the dough is made with yeast, and it has been recommended to set the doughs separately and combine them kneading. A similar process, I think, is to make the bread with baking powder, when it never fails to rise. Take care in mixing, however not to make the flours too wet, as the plantain flour is not capable of taking up so much moisture as the wheat flour.

Plantain flour cooked and eaten as oatmeal porridge is an excellent food and should entirely replace oatmeal on the breakfast table at the present time.

In cake making, the same proportions of plantain flour can be used as in the making of bread.

Use in the form of a milk pudding, made in the same way as a rice pudding, it is also very palatable.

Plantain biscuits can also be made from the flour, in fact they have been known in Europe as a fancy biscuit for a long time.]

CULTIVATION OF MAIZE.

(*Revised by SILVERIO APOSTOL, Chief of Plant Industry Division Department of Agric. Philippines*).

SELECTION OF SEED.

Soil, Climate, and the length of the growing season vary so much in the different countries and in portions of the same country, that it is very important that corn should be bred up in each neighbourhood. If we bring seed of the best corn from another country and plant it directly in our fields, we shall not get a maximum yield the first year because the seed was not acclimatized, nor was it "at home" in our soil. If, however, we select the best ears from the best individual stalks of those grown the first year and plant kernels from them in our field the next, we shall get a better crop of corn than we did the first year because the seed used in the second planting is more accustomed to our soil and climate; if we keep selectioning the seed ears from the best plants each year, after a while we shall have produced a variety of corn that is suited to the Philippines and will produce more per hectare than any other kind. In a like manner if we select our seed ears from the varieties of corn at present growing in the Islands and use them for our next seed, we shall get a larger yield than if we had not selected the seed.

Any planter who produces a strain of corn that is well adapted to these Islands will be able to sell good seed at a price profitable to his neighbour as well as to himself; and in so doing, he will be a benefactor to his locality, for he will be increasing the production of corn therein.

The main object in selecting seed corn is to produce more and better shelled corn per hectare than has ever before been produced. The most desirable type of corn for commercial growing in the Philippines is one that is a good yielder and very flinty—the more so the better—as this is not easily attacked by weevils, the principal enemy of the corn-grower in this country, and makes more "rice" and less flour.

The seed (*kernel*).—A kernel of corn contains a very small germ which when planted, will make a stalk of corn. If the seed we use is not the best, in a short time the strain will "run out" and we shall harvest a small yield. The stalks will be scrubby and yellow with only undeveloped ears on them. Then, too, unless we select good ears for seed, disease and insect enemies will develop to such an extent that corn-growing will beoome unprofitable.

A good stalk of corn.—Since the stalk is the individual, it is therefore necessary to select seed ears from stalks that are well developed, and this can be done only by selecting from standing stalks in the field at ripening time. Thus we are able to select seed corn from stalks that have produced heavily under average field conditions and in competition with other stalks in the same field.

A good stalk of corn should be without suckers, thick at the base, with well-developed roots, and gradually tapering towards the top. It should be free from "smut" or other diseases and should have from ten to sixteen well-formed blades, depending on the variety, and two good ears each attached by an ear stalk or "shank" about 8 centimeters in length. The ears should be well covered by the husk, to guard against weevils, and should point downwards; the lower one borne about one meter from the ground.

A good ear.—The ear should be symmetrical and nearly cylindrical in shape, well rounded at each end. The rows of kernels should be straight and compact, commencing close to the "shank" and extending clear over the end of the cob to the tip. The cob should be neither too large nor too small for the variety. The kernels should fit snugly, and be uniform in size, nearly flat on the sides fairly long, and slightly tapering on both edges ("wedge-shaped").

Selection in the plot.—As soon as the plants begin tasseling, the plot should be carefully inspected and all barren and poor stalks detasseled so that sterility will not be transmitted. Just before harvesting, the plot should be re-inspected to mark the desirable stalks as described above for the purpose of seed selection. When ready for harvest, the good ears, as indicated above, are to be saved for seed.

HARVEST AND CARE OF SEED CORN.

After we have selected our seed corn, the next thing to do is to preserve it until it is ready to be sold or planted. It is very important that all corn which is to be used for seed should be preserved in the best manner possible. Though seed corn may be thoroughly dried, it will absorb moisture again when it comes in contact with a damp atmosphere. When first harvested, seed corn very often contains from 20 to 30 per cent of moisture, and unless it is well dried, it may be ruined in a single day through heating, or, in damp places, molding.

Whenever practicable the seed corn should be allowed to mature and cure on the stalk thoroughly. Then the seed ears are removed from the stalks, with the husks on, and placed in a dry, well-ventilated place where weevils, ants and mice or rats cannot get at them. Where it is not possible to properly dry the seed corn on the stalk, the seed ears should first be spread out in the sun during the middle of the day until properly dried before they are finally stored up.

Storing.—Once dry, the ears should be tied by the husks into bundles of ten or any convenient number. Care should be taken, however, to leave as much as possible of the husk covering each seed ear. These bundles should then be hung on the rafters of the planter's home where they will not get damp, preferably in the kitchen. The smoke from the open stove drives the weevils away. Obviously only a few ears can be kept in this way. Where a large quantity of seed is to be saved, this can be stored advantageously by the *halayhay* method.

This method of storing seed corn consists in hanging up the unhusked ears systematically by their own stems, tips downward, on a bamboo frame or rack built in the open as follows :—

A number of strong posts, about 5 centimeters in length are set perpendicularly in the ground in a straight row, about 1·5 meters apart from each other. Then bamboo slats about 4 centimeters wide are nailed across horizontally, joining all the posts. The slats are placed one above the other in such a way as to allow the tips of the ears hung on the upper slats to overlap the "shanks" (stems) of those hung on the slats immediately below. The first slat from the ground should be high enough so as to protect the corn from roaming animals. Whenever convenient, slats should be similarly fastened on the opposite side of the posts in order to economise space by thus doubling the capacity of the *halayhay*.

The base of the posts should be buried deeply, not less than 70 centimeters, so as to make the rack strong. It is oftentimes necessary to provide the rack or *halayhay* with either guy-wires or braces to prevent it from being blown down by strong winds. The *halayhay* should be built near a building or some other windbreak, but not under the shade; it should preferably face from east to west, so as to admit as much sunshine as possible.

Corn for storing by the *halayhay* method should be gathered thus: (a) select the best, well-matured ears (without opening or in any way mutilating the husk) from the best individual stalks; (b) gather the ears so selected by cutting the stalk with a knife or (*bolo*) about 4 centimeters just below, and about 15 centimeters above the base (node) of the shank. The piece of stalk thus left on the shank forms with this a sort of hook whereby the ear may be hung up. Immediately after harvesting, the ears should be hooked over the bamboo frame, commencing with the lowest slat, and building upwards.

It is obvious that the method of selecting seed corn on the husk is faulty, in that there is possibility of getting ears of imperfect type. However, if proper care is taken in the selection, by picking the largest, best-proportioned, well-covered, well-matured and best-filled ears, as may be determined by the touch and judged from external indications, the number of undesirable ears may be reduced to a minimum. Before planting time, the seed ears should be tested by planting five kernels from the different parts of each in a germination box to determine their viability. The corn should be husked when needed for testing, at which time the final selection is made and the undesirable ears are discarded.

Weevils.—In the Philippines, as in all hot countries, stored grain is always damaged by weevils. These weevils are small insects, having snouts which they use to bore into the kernel of corn for the starch and germ contained therein. Therefore in storing corn, it is very important that farmers should guard against the attack of weevils. These insects can, to a great extent, be held in check by selecting those with husks that fit tightly over the ears and by planting varieties with hard kernels (flint corn). The simplest and most effective method of eradicating them in stored corn, however, is by fumigating with carbon bisulphide, a colourless liquid with a strong, disagreeable odour, which kills the insects. It evaporates very quickly, but is a powerful poison and highly inflammable.

How to apply carbon bisulphide.—The seed corn should be placed in a tight barrel or deep box, which is provided with a hole in the side near the bottom. The hole should be kept plugged during fumigation after which the plug is removed for the gas to escape. About 30 grams of carbon bisulphide, in a saucer or on a piece of cotton, is then placed on top of the corn, and the box or barrel kept tightly covered for six hours.

The carbon bisulphide rapidly volatilizes or turns to gas, and being heavier than air, descends and permeates the mass of corn, killing all insects or vermin present.

Carbon bisulphide retails in Manila at present (January, 1919, for $3 a kilo).

Caution.—The vapour of carbon bisulphide is deadly to all animal life if inhaled in a sufficient quantity, but there is no danger in inhaling a small amount. The vapour is very inflammable, and a lighted cigarette or cigar should not be brought in contact with it. Carbon bisulphide does not injure the grain for feeding purposes or in germination.—PHILIPPINE FARMER, Vol. V., No. 2.

ONIONS AND ONION-GROWING.

As the time approaches for preparing for an onion crop, it will not be out of place to give directions for sowing the seed and for the after-cultivation of this most valuable vegetable. There is no reason why onions should be imported in such quantities as we see daily arriving by steamer from the Southern States. The climate here is perfectly adapted to them, and, if only planted on suitable soil and given the necessary attention, heavy crops are an almost certain result. At one time it used to be said that onions could not be profitably grown as a field crop in the Blenheim district, near Laidley. To disprove this, the writer determined to experiment on the sandy loam of the scrub land on Sandy Creek. The seed was sown in April: the variety, Brown Spanish. The land to which they were to be transplanted was well worked and then rolled to make a hard, compact bed. Transplanting as carried on throughout July, and the season having proved favourable, the result was a heavy crop of magnificent bulbs, which gave a splendid return for the labour expended. Now, if such a result can be obtained by one farmer, it follows that others can do the same. As there are thousands of acres of similar land under cultivation both there and in many other portions of the State, it only requires determination on the part of the farmers to enable them to successfully displace the importations from the South.

On looking over an old diary of farm operations, it appears that the writer's crops averaged 6 tons per acre, and sold at £25 per ton. Are there many crops which will give a like return? The present price of onions in the market is about £24 per ton. Now, suppose a crop to yield 8 tons per acre (and we know that double that return has been made), the cash return for a medium crop will amount to £192. Certainly there is a considerable amount of labour involved in planting out an acre or two of onions, but that labour is amply compensated for by the nett return.

A consideration of the following Notes, based on practical experience, may, therefore, be of some service: Let us first consider

THE SOIL.

The most suitable soil for onions is a rich sandy loam, such as that of the Blenheim scrubs-free, friable, and easy to work, a soil that will not cake, and not lying so low as to retain the super-abundant moisture after heavy rains. In such a case the land should be well drained. An eastern or south-eastern aspect has been proved to be better than if the land sloped to the west, as the onion does not require intense heat to bring it to perfection.

Before sowing the seed, it is important that the seed beds should be clear of weeds and of their fallen seeds. By sowing in April or May there is not much to fear from weeds; still, it is advisable that the land, both of the seed beds and of the area proposed to be planted out, should be turned up and exposed to the weather for some time previous to sowing. As soon as the weeds appear, give the land a good scuffling, and if this be done two or three times between March and April there will be no trouble afterwards. If the soil be not virgin scrub, or if it has borne crops for many years in succession without manuring, it should be thoroughly well manured with stable-dung, ashes, bone-dust, etc. as the onion demands plenty and the best of nourishment. New scrub land is rich enough in natural fertilisers not to require any addition of manure.

PREPARING THE SOIL.

In planting out onions, a very serious mistake is often made, and that is, the soil is carefully worked, reduced to a fine tilth, and the plants are set out in a soil which is loosened to a depth of perhaps 8 inches. From land prepared in this manner no good results need be expected. The onion requires a firm bed; otherwise the plant, instead of making a large

well-shaped bulb, will run to neck, and have more the appearance of a leek than of an onion. Therefore, the land before being planted must be well solidified by rolling.

THE SEED BED.

Onions may be sown broadcast, or they may be drilled in, or they may be sown in a seed bed and afterwards planted out in the same manner as cabbages. The best way is drill them in. In this case, about 2 lb. of seed per acre will be required. The seed must be dropped at a distance of about 2 inches apart in the drill, and the drills should be from 12 inches to 15 inches distant from each other. The plants will afterwards require thinning-out with the hoe. When sown in seed bed, planting out must be resorted to—a tedious process, but one that pays well for doing well.

On rich soil the plants may be 6 inches apart. The drills should be slightly raised, and the roots of the plant firmly embedded in it—allow the bulb to, as it were, squat on, not under the surface. As the plant grows, the soil must be kept perfectly clear of weeds, and, where the working of the ground has thrown the soil against the bulbs, it must be drawn down, so that only the root is in the ground. Where this has not been attended to, the remedy for the resulting want of bulb formation is to wring the necks of the plants, or, at least, to bend them down with a twist. This will have the effect of inducing the formation of bulbs.

When sowing the seed, care should be taken that they are not covered to more than their own depth. If sown deep, many seed fail to germinate, and most of those that do appear will make an abnormal growth of neck, causing much labour in drawing away the soil from the incipient bulbs. The writer has never sown onions broadcast, and therefore offers no opinion on the value of the method. Of course more seed would be required per acre, and, if weeds are troublesome, a good deal of hand work would be necessary.

Now, about the seed :· There are few seed so annoyingly deceptive as onion seed. So difficult was it to get good seed in the State even at 10*s*. per lb. in the good old days, that growers imported it from Spain. The largest growers at Oxley, Messrs. MARTINDALE & NOSWORTHY, were most successful with imported seed, but the writer had a very bad experience in this business. Twenty pounds weight of onion seed was sent from a friend in Germany. Instead of packing it in hermetically-sealed bottles, he stowed it in calico bags in the body of an immense wooden Swiss cuckoo clock. When the clock was opened the bags of seed were examined and looked perfect in colour and shape ; but, alas ! When subjected to pressure, no oily fatness was perceived ; and when at last it was given a chance and sown thickly in drills, five acres returned the magnificent yield of 72 lb. which, at the rate of £28 per ton, amounted to 18*s*. Certainly, the land, after a week's waiting for the seed to germinate, was utilised otherwise, but not 1 cwt. of onion was harvested.

Make sure, therefore, of the seed. After sowing, it should germinate in less than a week.

In former days large onions were always aimed at, but now the public taste is in favour of medium-sized bulbs, so that closer planting may be adopted.

Onions may be known to be ripe by the drying up of the tops. As soon as this happens, take them up by hand and leave them on the ground between the rows to dry. · As soon as they are dry, carry them carefully with as little bruising as possible to the barn.

As before stated, the Brown Spanish has proved most successful in this State, but the gentlemen above-mentioned grew what they called the large White Portugal onion. It certainly was a splendid bulb, and fetched very high prices in the markets of Brisbane, Maryborough, and Rockhampton.—QUEENSLAND AGRI. JOURNAL for April, 1919.

THE PRODUCTION OF TAPIOCA IN THE DUTCH EAST INDIES.

The cultivation of manioc *(Manihot utilissima Pohl)*, from whose starchy root tapioca is produced, has only recently been developed in the Dutch East Indies, although, already in 1854, official initiatives were taken. The aim of the Government was to provide the native with an "auxiliary foodstuff" with the object of guarding against the lack of ordinary foods, especially rice, in time of famine. The population required several years in order to appreciate the utility of this crop, which now is fairly well diffused. The analysis of the manioc roots, made at the Laboratory of the Colonial Museum at Haarlem, gave the following results for fresh and dry samples respectively: nitrogen, 0·26 and 0·50 per cent.; albuminoids, 1·63 and 3·30 per cent.; fats, 0·94 and 1·90 per cent.; carbohydrates (expressed as starch), 39·79 and 80·60 per cent.; crude fibre, 2·10 and 4·25 per cent.; ash, 0·24 and 0·48 per cent. The fresh sample contained 50·63 per cent. of water.

The native population eats the roots as they are—skinned, then cooked or boiled—or mixed with other ingredients. The product for export is prepared in works, now very common, especially in Java. In this way are obtained: (1) manioc or cassava flour ("tapioca-meal"); (2) those products, prepared under another form and higher priced, called "tapioca perle" and "tapioca flake." The dried manioc roots and the by-products obtained in preparing the flour are also exported. The exports are mostly towards the United Kingdom, the United States and the Netherlands. The number of metric tons exported from 1915–1917 are given below:—

Products	Destination	1915	1916	1917
Manioc flour	Netherlands	7,279	79	227
	United Kingdom	14,650	13,261	7,549
	France	3,273	511	58
	United States	13,344	37,655	31,473
	Penang	38	639	1,475
	Singapore	2,606	4,854	5,618
	Hongkong	1,847	2,313	2,896
	China	104	197	321
	Japan	—	57	475
	Other Countries	706	55	206
	Totals...	43,847	59,621	50,298
Manioc by-products	All countries	2,612	913	103
Dried manioc roots	" "	31,546	8,378	1,522
Pearl tapioca	" "	459	1,186	4,812
Tapioca flake	" "	5,566	6,214	13,005

CEYLON AGRICULTURE.

COMMITTEE OF AGRICULTURAL EXPERIMENTS.

(Minutes of the Proceedings of a Meeting of the Committee of Agricultural Experiments held on Thursday, 8th May, 1919.)

The meeting commenced at 3 p.m. Present: The Director of Agriculture (Chairman), the Hon'ble the Government Agent, C. P., the Botanist & Mycologist, the Government Entomologist, the Superintendent of Botanic Gardens, the Superintendent of School Gardens, the Hon'ble the Rural Member, the Chairman, Planters' Association of Ceylon, the Chairman, Low-Country Products' Association. Messrs. N. K. Jardine (Entomologist for Tea Tortrix), W. B. Wilson (Tobacco Expert), R. G. Coombe, J. B. Coles, H. D. Garrick, G. H. Masefield, W. G. B. Dickson, A. W. Beven, Mudaliyar A. E. Rajapakse, Graham Pandithasekera and H. A. Deutrom (Acting Secretary); and as (Visitors): Messrs. T. Finch Noyes, C. C. Villiers, A. W. Bisset, John Horsfall, N. D. S. Silva and J. Duncan.

The minutes of the previous meeting having been taken as read, were confirmed after embodying one amendment. The Chairman stated that His Excellency regretted his inability to be present at the meeting. The following gentlemen also have informed of their inability to attend the meeting: Messrs. Huyshe-Eliott, A. S. Long-Price, J. S. Patterson, L. A. Wright, A. Bruce (Acting Government Agricultural Chemist), the A. G. A., Puttalam, and Sir Solomon Dias Bandaranayake.

The Chairman then announced to the Committee that His Excellency has been pleased to nominate Mr. Huyshe-Eliott, Mr. L. A. Wright and Mudaliyar Rajapakse to be members of the Committee, the former two in places of Messrs. T. Y. Wright and A. J. Austin Dickson and the last in his personal capacity.

MR. J. B. COLES inquired if there were any vacancies in the Committee, and if so he proposed the name of Mr. David Cameron to serve on the Committee. The Chairman said that the present Committee had no definite number of members, but that re-organisation was under consideration. The proposal would be kept in view.

The Progress Reports of the Experiment Stations, Peradeniya and Anuradhapura were briefly reviewed by the Chairman who said that the usual work had been carried out at Peradeniya. The main work of paving drains in the Tea areas is being continued. The new paddy land is being levelled, beans and other food crops have been replanted. The sweet potato crop is being harvested and cuttings of different varieties were available. The paddy crop an account of which was included in the report, was satisfactory, the Hathial variety being specially suitable to the District, the other introduced varieties too giving good crops. At Anuradhapura the planting of fibres and food products were being pushed on and a *Yala* crop of paddy sown.

AGENDA.

1. *Cacao Manurial Experiments, Peradeniya.*—The Chairman stated that the percentage of squirrel pods had increased. This was due to the difficulty in procuring percussion caps, but a supply of caps has recently been obtained and a large number of squirrels are now being shot. The Chairman in summarising the report of cacao manurial experiments at Peradeniya, stated that Organic Nitrogen gave slightly higher returns than Mineral, but the difference is decreasing. In series 3 the reverse is shown. Considering that all plots where Nitrogen is omitted are improving, it would indicate that when humus is maintained from the leaves of the cacao and from the leaves of shade trees, the further addition of Nitrogen in the form of artificial manure is unnecessary. The plots which are being wholly forked are all improving: in series 1 considerably, in series 2 moderately, and in series 3 slightly. This is probably due to the effect of the forking, as the plots receiving the same mixture containing Mineral Nitrogen, but without forking, do not show any marked change and such change as is being recorded being somewhat in the downward direction.

Control Plots all show a falling-off. This is doubtless due to there being no cultivation at all carried out on these plots. For the manured plots some light cultivation is done in the application of manures. In the Control Plots this is not done. It should be carried out to make all the cultivation factors equal. THE HON. MR. G. SINCLAIR suggested forking one of the two Control Plots in each series of the experiments. The Committee after discussion, decided that the results of the experiments be brought up again at the end of the year. It was decided to publish the summary of the results.

2. *Tea Tortrix Experiments.*—The Chairman circulated copies of the report on this, and called upon MR. JARDINE to give an account of his experiments carried out at Maskeliya. He stated that the experiments have not yet been completed, but he thought that the members would like to know what is being done. MR. JARDINE'S report summarised is as follows: The Tea Tortrix investigation has been to find a practically useful wash which would kill Tortrix and make the tea bush distasteful to the insect; the proposed scheme of spraying is part of the remedial and preventive measures suggested in Bulletin 40; the main suggestion was to have a series of Wind Belts or Tortrix Flight Breaks of leguminous trees protecting those ridges exposed to the South-West Monsoon, which is responsible for the wholesale distribution of the Pest. These flight breaks may be either Dadaps, Grevilleas, Acacias or Albizzias according to the growing capacity of the plants in the particular districts; or two adjacent rows of tea allowed to grow into seed-bearers. These flight breaks were the main scheme of prevention, for they will check the distribution of the pest, insure the plants to some extent from infection from his neighbour and will prove a local breeding ground for the pest. Let the pest come and establish itself in the flight breaks and it will be simple to kill out cheaply with sprays. When these flight breaks are in use, tea must be protected from attack emanating from the flight breaks, for there is a big chance that after overcrowding in the flight breaks, the insect will attack the adjacent tea.

The investigation has been established in Maskeliya for five months experimenting, to prove the efficiency of a particular chemical which may be used on tea with no harmful effect to the marketable product or on the

flushing of the bush, but which will kill the insect and make the bush distasteful to it. As the investigation was satisfied by preliminary experiments and previous experience of the chemical with a similar Tortrix, that the wash would kill the insect. The Maskeliya experiments were instituted to prove beyond doubt that the application of the chemical had no deleterious effect upon the flushing capacity of the bush or upon the made tea. The methods of his experiments were then explained by MR. JARDINE : (1) The washes in no way injure the bushes. (2) insects do not exist in the treated plots. (3) the yield of the treated plots is greater, than that of the untreated. (4) No. 2 wash materially improves the sample by bringing out the flavour. (5) Rain has no effect on the washes once they have dried on the leaves. (6) Costs of spraying are high, but the experiments combined every difficulty likely to be met with and in practice should never exceed half the costs stated. (7) Difficulties of water transport may be materially lessened by sinking a small reservoir in the area to be treated. (8) The washes may be simply manufactured on any estate. The cost of labour works out at Re. 1·60 per acre and the mixtures cost as follows : Mixture No. 1. Rs. 9·58½ and No. 2, Rs. 11·47½ per acre each. MR. JARDINE said that MR. FINCH NOYES, Chairman of the Maskeliya Planters' Association had visited the experimets and would testify to the results obtained. MR. FINCH NOYES said that the experiments were carried out under very unfavourable conditions. There was a severe drought. No bad effect was made on the tea, but on the other hand it improved the quality of the tea. The insects and blights were all destroyed in the treated plots. MR. WRIGHT inquired what it was in the wash that improved the flavour of the tea, and MR. JARDINE said that it was probably the Sodium Carbonate. On MR. COOMBE'S enquiry, MR. JARDINE said the compositions of the washes were as follows :—

No. 1 wash ... 1 oz. Lead Chromate for 4 gallons of water.

No. 2 ,, ... 1 pint Rosin Compound, 1 oz. Lead Chromate } for 4 gallons of water

(2 lb. Rosin and 1 lb. Sodium carbonate in 3 gallons of water.)

The Chairman said that the experiments, although not yet complete, were giving promising data.

3. Tobacco Experiments.—The Chairman called upon MR. WILSON to give an account of his experiments, and said that MR. WILSON had only been 6 months in the Island and that his plots at Teldeniya for cigar type of tobacco have only been recently established. MR. WILSON said that transplanting of tobacco at Teldeniya began on April 19th. The plan is to grow mostly native seed to test this type under good ordinary methods of cultivation and curing, also to study this type for the possibility of improvement through the selection. Secondly to grow a small number of exotic types of cigar tobacco to test the product against their own type and that of the native seed. He stated that ten different types have been sown. The germination of the introduced kinds was poor, and some trouble had been experienced in the nurseries from fungus The disease was checked with Bordeaux Mixture. To the 30th April 26,000 native plants have been transplanted and 5,800 plants of the exotic strains. One plot of the tobacco is to be specially fertilised to give a general idea as to whether fertilising experiments should be undertaken. MR. WILSON is now trying to secure seed from abroad for trial at the next season. Considerable difficulty was experienced at Teldeniya with snails. With regard to experiments at Jaffna, the plan was to grow a commercial crop with which to test the European market on a business basis. Nurseries were put in October, but these failed. The floods of November did considerable damage to the nurseries and buildings. Other nurseries were put in at the end of November and beginning of December, and a large number of seedlings were produced. In comparison the Turkish had done

better from standpoint of growth than White Burley. The land intended for tobacco was all sown with Sunn-Hemp and ploughed in December. Transplanting was begun in January 2nd. Shortly after transplanting, the seedlings were found to be infested with eel-worm, and it appeared that the entire land was heavily infested, which was made worse by late transplanting. All the plants of White Burley have been harvested and 320 short laths have been sun-cured. 550 long laths of Turkish have been reaped and are curing. A record of temperatures, rainfall, and humidity was kept for some time during March and the conditions for the sun-curing of this type of tobacco are excellent. Co-operative plots were to be undertaken by 5 local planters there, but only MR. V. M. MUTTUKUMARU, the Maniagar of Jaffna, succeeded in raising about 1,000 plants. Two specimens of sun-dried leaves were handed round to the members.

4. Flies introduced in manure mixtures, and the possibility of treating certain manures by heat or otherwise to destroy eggs or larvæ before despatching from Colombo.

The Chairman stated that although this question was brought forward by MR. L. A. WRIGHT, who was absent, he would like to deal with it. During a recent visit to Maskeliya, his attention had been drawn to the plague of flies. It was thought that this was due to the use of fish-guano as manure, and it was agreed that investigations should be made with a view to ascertaining if this view was correct.

MR. JARDINE gave the result of the experiment he had carried out. MR. JARDINE said as a result of these experiments, he was of opinion that it was not due to manures. The ENTOMOLOGIST also said that fish-guano did not account for the breeding of flies, even when moist. He said that the flies may feed on it, but would not breed. He gave the life-history of the house-fly and a resumé of the experience of other countries. It was decided to continue the experiments further.

5. Inducements to villagers to visit Experiment Stations.—The Chairman said that this question was raised by MR. W. L. KINDERSLEY, and called upon members for suggestions. After discussion, it was decided to make an effort to get parties of villagers to visit Experiment Stations with Headmen, and the Chairman said that he would take up the matter as far as Peradeniya was concerned with the Government Agent, Central Province.

6. Increased Food Production.—The Chairman called upon DR. HEWAVITARNE in whose name the subject stood, to speak. DR. HEWAVITARNE briefly outlined a scheme for increasing food products. His scheme was to form a large Co-operative Society which the Government and a powerful combination of capitalists should work. The villagers being poor could not individually undertake to start any new work. A Society of this kind would greatly assist the villagers. The work could be done on the village system and labourers should be got from Matale, Dambulla and such other places. He thought that a Settlement could be started under Nachchaduwa. They could settle on the land or come to work during sowing and reaping. A general discussion ensued and various matters in connection with the further productions of paddy and other foodstuffs were raised. The Chairman requested DR. HEWAVITARNE to draft a definite scheme to be considered.

7. MUDALIYAR RAJAPAKSE exhibited the first flower of his coconut plantation: Rajapakse-Kumarewanni-yaya (Puttalam), planted in June. 1915 and flowered in the middle of February, 1919, 3 years and 8 months from planting.

The meeting terminated with the usual vote of thanks.

H. A. DEUTROM,
Acting Secretary,
C.A.E.

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA.

(From 1st March, 1919 to 30th April, 1919.)

TEA.

1. The yield for the month of March was 1,255 lb. green leaf from 11 acres, that for April 5,636 lb., being an excess of 4,381 lb. over the previous month.

2. The January made tea fetched in Colombo 49 cents per lb. for broken orange pekoe, and an average of 33·83 cents. per lb. for all grades.

3. The single and Assam hybrid bushes which were yielding small crops were slashed across as decided at the last meeting of the Committee of Agricultural Experiments.

4. Holes in the old and new plots have been dug and cattle manure put in for planting the vacancies as soon as the rains have set in.

5. The Manipuri indigenous seed from Kotiyagalla, which were put out in supply baskets, is doing well.

6. The paving of main drains in the new tea has been completed, and improving the drains in the old plots is now being undertaken.

RUBBER.

7. Plots 83 A, B, D; 84 A, C, D; 85 D and 86 A were manured with the various mixtures. The manures were applied in a central trench 6 inches deep and 3 feet wide. The fallen leaves were then swept into the trench and lightly forked in.

8. The two-acre plot planted in avenues, 40 ft. × 15 ft. × 15 ft. has been lined and manured according to the scheme.

9. Holes have been dug in the young plantation for planting the vacancies.

10. The drains between the manured plots have been cleaned out.

11. All dead branches of rubber trees have been cut out and burnt.

CACAO.

12. One round of picking has taken place, yielding a small gathering.

13. A further consignment of cacao was despatched to Colombo and realised the top price of Rs. 72 per cwt. (unsorted).

14. The round of light pruning and removal of suckers has been continued.

15. A round of canker treatment has been finished.

16. Series I and III (old cacao) were manured according to the scheme laid down in 1916.

17. The *Leucanea Glauca* and *Tephrosia Candida* in the hillside plot of 3 acres above plots 73-77 has been uprooted and cleared. Steps are being taken to supply up vacancies.

18. The yields of the Cacao Plots for 1918-1919 will be tabled.

COCONUTS.

19. 45 supplies have been planted out along the river bank at the Getambe end.

20. There has been no sale since the last meeting.

COFFEE.

21. The dadap, Leucanea Glauca and Gliricidia shade over the coffee have been pruned, and prunings mulched round the plants.

22. The removal of suckers is in progress.

23. The crop of Robusta is now over, and further seed will not be available until September next.

PADDY.

24. The different varieties of paddy transplanted early in October have all been harvested. The results are satisfactory, 3 acres yielding 120 bushels of clean-winnowed paddy. The results are appended.

25. Many villagers and headmen were shown the standing crop, the methods of improved cultivation, and the proper methods of water-control were explained.

26. The fields have been prepared and sown for the *Yala* crop, ½-an-acre has been sown with Molagu Samba Paddy broadcast at the rate of one bushel per acre. The remaining 2½ acres have been sown with Heenati paddy. The whole of the field was manured with the following manurial mixture, before sowing, ¼-ton being applied to 3 acres :—

		Nitrogen.	Phos. acid.
100 lb.	Fish Guano	8 lb.	8 lb.
100 ,,	Bone Meal	3	22
100 ,,	Crushed Bones	3	22
75 ,,	Groundnut Cake	5·25	
25 ,,	Sulphate of Ammonia	5	
400 lb.		24·25	52

equal to 6·0625 % Nitrogen
.13 % Phos. Acid

27. The low land below the Meteorological Station has been ploughed and ridges made. Levelling the land for paddy is in progress.

FOOD PRODUCTS.

28. *Sweet Potato.*—The different varieties of sweet potatos introduced from Mauritius are being lifted. The cuttings were planted in November last year. Records of cultivation, crop, etc., will be embodied in the next Report.

29. Cuttings of the ten varieties are still available at Re. 1 per bundle of 100 cuttings.

30. *Dhall.*—Plots 11 and 12 (Young rubber) have been sown with a garden variety of dhall. 4 rows were planted between the rubber leaving 5 feet on either side of the rubber.

31. *Field beans.*—Seed from the previous crop of the following varieties have been sown in the show plots round the office, large white Haricot, large white Kidney, Moolman field bean, Canadian Wonder, Lima double beans, Rose Coco, Lima Henderson Bush, and Rooibekje field bean.

32. *Dura.*—Seed of the best heads of the 6 varieties harvested in March, has been re-sown in plot 119 in order to obtain a quantity for distribution to cultivators next season. A fair quantity of selected seed is now available for distribution.

33. A variety of Red Jowari obtained from Hyderabad, India, has been sown.

34. *Maize.*—The following varieties of Maize were planted out in plot 19, seed being specially selected from the last crop:—Chester Co., Mammoth, Eureka and Hickory King.

GENERAL.

35. *Economic Section.*—The removal of stumps is in progress.

36. *New works.*—The upper river section is being cleared. The lower section in grass and palms has been weeded.

37. A small reservoir and a channel to carry the water has been built to assist in the irrigation of the new paddy land.

38. Sanitary precautions have been taken with regard to the cooly lines and public buildings on the Station.

39. *Pests.*—Snails are on the increase, in spite of being collected and destroyed regularly. Squirrels are being shot.

40. *Forest Reserve.*—A quantity of valuable timber trees in the Eriagama boundary are being cut and removed by an ex-Registrar who claims a portion of the land as ancestral property. The matter is in the hands of the Government Agent, Central Province.

41. *Labour.*—The health of the coolies has been satisfactory.

42. 32 visitors have been shown round the Station since the last meeting.

43. *Rainfall.*—March 7·10 inches 6 rainy days
April 6·08 „ 15 do

Results of Paddy Experiments (referred to in para 24)

Name of variety	Date of sowing	Date of transplanting	Date of flowering	Date of Harvesting	Yield calculated to the acre. Clean paddy bushels.
Hathial	4.9.18	7.11.18	15. 1.19	17.3.19	53
Muttu Samba	2.9.18	5.11.18	15. 1.19	14.3 19	45¾
Molagu do	2.9.18	11.11.18	3. 1.19	25.2.19	43¾
Philippine	4.9.18	4.11.18	10. 1.19	7.3.19	24½
Dr. Lock's Hathial	2.9.18	6.11.18	20.12.18	12.3.19	15¼

H. A. DEUTROM,
Acting Manager,
E. S., Peradeniya.

PROGRESS REPORT OF THE EXPERIMENT STATION, ANURADHAPURA.

(From 1st March, 1919 to 30th April, 1919.)

1. The Acting Manager has made two visits of inspection since the last Report.

2. *Paddy.*—The new area of 3 acres sown broadcast with the Philippine variety of paddy are stooling well, and show a remarkably vigorous growth.

The different varieties transplanted in November have all been harvested. As the whole crop has not yet been threshed, a detailed table of yields will appear in the next report. The plots are being prepared for a *Yala* crop.

3. *Limes.*—The plants are vigorous and healthy. The vacancies are being supplied.

4. *Fibres.*—The vacancies in the plot of Mauritius hemp have been supplied. The sisal fibre area has been planted up with 11,723 suckers from the Maha Illuppallama Station. The plants are growing well in spite of the long continued drought, some of the plants forging far ahead of their neighbours. The stronger and older plants of 12-18 inches have made better and quicker headway.

5. *Coconuts.*—Vacancies in the 3-acre plot of coconuts planted in December 1916 have all been supplied, with plants from the Maha Illuppallama Plantation. The land has been disc-harrowed. The plot of coconuts between the paddy and cooly lines have been ploughed and disc-harrowed.

6. *Coffee.*—The general appearance of the Robusta Coffee trees grown under dadap and gliricidia shade is favourable. 60 lb. of berries have been picked off the trees at one picking.

7. *Food products and currystuffs.*—The first small plots of currystuffs did not grow well. Subsequent plantings have done better. Chillies and onions give promise of most satisfactory crops. Attempts will be made to induce the local villagers to visit the Station and see for themselves the excellent crop of chillies grown under irrigation. Dhall, chillies and turmeric are being harvested. Fresh seed and tubers could be supplied to *bona fide* growers. Plots of chillies, onions, lima beans, Jaffna yams and sweet potatos, have been planted.

8. *General.*—The Madras thorn hedge along the main road has been pruned, and seed for extending the fence has been ordered from India.

Castor vacancies in the lime and fibre plots have been supplied, and the plants propped up. The dry seed is being collected. The cattle-shed has been re-thatched and the floor laid with gravel.

8,000 coconuts were picked from the Maha Illuppallama Station, and sold at Rs. 55 per 1,000, delivered at Maha Illuppallama.

The erection of new posts round the boundary fence is in hand.

The portion along the main road has been completed.

The plot of betel has been re-planted.

It is proposed to build a set of cooly lines with better accommodation and sanitation, on a more suitable site. The present lines are very unsatisfactory.

H. A. DEUTROM,
Actiug Manager,
D.Z.E.S., Anuradhapura.

CACAO MANURIAL EXPERIMENTS AT PERADENIYA.

The following is a summary of the results of the Cacao Manurial Experiments carried out on the Experiment Station, Peradeniya. These experiments were remodelled in 1915, and the summary now issued is based upon the results obtained during the crop years of 1916-17, 1917-18 and 1918-19 :—

Organic Nitrogen has given slightly higher returns than Mineral, but the difference is decreasing. In series 3, however, the reverse is shown.

Considering that all plots, where nitrogen is omitted are improving, it would indicate that when humus is maintained from the leaves of the cacao and from the leaves of shade trees, the further addition of nitrogen in the form of artificial manure is unnecessary.

The plots which are being wholly forked are all improving ; in series 1 considerably, in series 2 moderately, and in series 3 slightly. This is probably due to the effect of the forking as the plots receiving the same mixture containing mineral nitrogen, but without forking, do not show any marked change, and such change as is being recorded being somewhat in the downward direction.

Control plots all show a falling-off. This is doubtless due to there being no cultivation at all carried out on these plots. For the manured plots some light cultivation is done in the application of the manures. In the control plots this is not done. It should be carried out to make all cultivation factors equal.

MINUTES OF FOOD PRODUCTION COMMITTEE MEETINGS.

MATALE.

Minutes of a meeting of he Matale Food Production Committee held at the Kachcheri, Matale on March 19th, 1919, at 2 p.m.

Present :—The Assistant Government Agent, Matale (in the Chair), Mr. A. B. Thomson, Mr. H. D. Garrick, Mr. C. P. Anderson, the Ratemahatmeya, Matale North, the Ratemahatmaya, Matale South, Mr. A. Madanayake, Agricultural Instructor ; and Mr. R. A. Senior-White, Honorary Secretary.

Minutes of last meeting were read and confirmed.

Pelwehera Tank.—Considered D.I.E's letter No. 23 of 17th March, 1919. It was decided after discussion to await report of R. M., North at next meeting.

Instructor's monthly Reports.—Owing to a misunderstanding, these were not to hand.

Hony. Secretary to advise Instructors *re* forwarding same. It was decided that with the Staff of Instructors available, these men should not tour outside the presently-supervised portion of the district.

Estimates for 1918-1919 and 1919-1920. Considered report of Sub-Committee and approved same.

The Chairman moved the following resolution to be forwarded with the Estimates, which was adopted :—

"That this Committee is of opinion that the output of paddy from fields under village irrigation works is far less than the irrigable lands are capable of yielding, that this position of affairs is in large measure due to the carelessness and indifference on the part of the irrigation headmen in regard to the prompt and strict application of the local cultivation rules, that the appointment of as large a number of Agricultural Instructors as possible working under the Assistant Government Agent and charged with the supervision of the irrigation headmen should result in a largely-increased yield of paddy from such lands, and that this Committee considers that for this purpose the appointment of 8 Instructors is imperatively necessary, and that these should be provided as early as possible."

Kalundewa Tank.—Considered R. M. North's proposal for the restoration of this tank, and decided in light of figures furnished by the Director of Irrigation in the past that any scheme is impracticable on the grounds of prohibitive cost.

Irrigation matters at Tibbutumulla.—Hony. Secretary put in a report from the Assistant Agricultural Instructor. A. G. A. announced that he was visiting the place shortly and had the matter in hand.

Saxton Park Experimental Garden.—An application by the A. I. for sticks for use therein was left over until the next Local Board Meeting.

Tobacco Growing.—Considered letter from the English & Scottish Co-operative Wholesale Society, and decided that this was not a matter for the Committee.

Kaikawela School Garden.—A. G. A. will look into this matter with a view to acquisition of the land.

BATTICALOA.

Minutes of the meeting of the Food Production Committee held at the Batticaloa Kachcheri on Saturday, the 12th April, 1919, to consider :—

1. The question of chena cultivation; and

2. What methods should be adopted for improving the cultivation, so that it will be more productive and less wasteful.

Present :—R. A. G. Festing, Esq., (in the Chair) and Messrs. S. Kumarasamy, S. N. G. Eliyatamby, Mudaliyar, S. W. A. Canakasabey, Vanniah Mudaliyar, Manmunai (North) K. Kantappody, Irrigation Vanniah ; and Mukamatulevvaippody Hadjiar.

Minutes of the last meeting were read and confirmed.

Colonial Secretary's Circular No. 18 of 13th March, 1919, and Government Agent's reply thereto No. 93 of 1st April, 1919, were read and the Committee supported the views expressed therein by the Government Agent.

Read letter No. 97 of 2nd April, 1919, from the Government Agent in reply to Government Circulars Nos. 7 and 13.

The question of the improvement of the method of chena cultivation was next discussed at some length. No one in the district had had an experience of crop rotation, and it was felt that without a practical demonstration carried out under the guidance of some officers of the Agricultural Society, little progress could be made.

The Government Agent informed the meeting that he would be prepared to consider applications for free grants of chena land for experiment in the rotation of crops.

AGRICULTURE.

SCHOOL OF TROPICAL AGRICULTURE, PERADENIYA.

(Report on 1917-1919 English Course).

On the results of the first School Course in English, January to December, 1916, recommendations were made to extend the period of the Full Course to two years, each year commencing in May, and ending in March, so as to synchronise more nearly with the agricultural seasons. These recommendations were adopted for the class admitted in May, 1917, when thirty candidates were selected for admission, out of eighty-two applications received.

As in the majority of the secondary schools and colleges in Ceylon, the year ends with the Christmas vacation in December, each full course in Agriculture is advertised in the "Government Gazette" and the daily papers in December and applications are received and recorded for consideration up to February 1st. This is intended to afford to all students who complete their secondary education in any December and decide to take to planting, the opportunity for obtaining particulars and sending in their applications in time. No students can be admitted during a course. Only a limited number can be admitted to each course.

The students admitted in May, 1917, completed their course in March, 1919. The course consisted of four sessions covering 87 weeks of work. As a rule, the mornings were given to field work commencing at 7 a.m., and the afternoons to classroom work commencing at 1 p.m. The fieldwork consisted of the cultivation by each student himself of a plot of land with four sets (one each session) of economic crops in rotation; and of demonstrations and practical work connected with the various operations of planting and horticulture. The plotwork and planting demonstrations were conducted at the Experiment Station, Peradeniya; the work in horticulture in the Royal Botanic Gardens.

The crops cultivated by the students during the course were; sorghums, maize, hill paddy, kurakkan; brinjal, bandakka, onions, chillies; cow pea, dhall, lima bean, green gram, groundnut; coriander, cummin, aniseed, fenugreek. The operations connected with cultivation, such as ploughing, harrowing, draining, manuring, etc., were studied and applied, and the results proved to be satisfactory. Careful records, called "Plot Diaries," were kept and diseases and pests appearing on crops studied and methods of control employed.

The planting, cultivation and preparation of the following products were studied: coconuts, tea, rubber, cacao, coffee, paddy, grains, plantains, papaw, vanilla, fibres, sugarcane, orchard and vegetable crops, and green manures; with the pests and diseases associated with them and methods of control.

In horticulture, the subjects of instruction may be summarised as follows: propagation, grafting, inarching, budding, pruning, storing, packing,

transporting, pollination, felling, lawn making and the study of useful and ornamental plants.

The classroom instruction was grouped under five heads, the instruction in each sub-division having been intended to give a general survey of the elementary principles of each. These divisions were : **Agriculture,** mainly fieldwork, also Agricultural Engineering comprising, chain surveying, roads and drains, machinery and buildings, and Elementary Meteorology ; **Agricultural Botany** covering General and Economic Botany and the Diseases of Plants ; **Agricultural Zoology** covering cattle, their breeding, feeding and diseases, dairy practice, and Plant Pests ; **Agricultural Chemistry** including elementary plant, soil and animal chemistry, the study of soils, manures and manuring ; and **Agricultural Economics** comprising Co-operation and Estate Accounts.

In Co-operation, the work of Co-operative Credit Societies as established in the Island was studied, the lecturer being the Secretary of the Board of Control. Several Passed Students have associated themselves with the work of such societies and accomplished good work.

In Estate Accounts, the work done has been of a high standard and was conducted by MR. D. CLEMENT DE SILVA, Chief Clerk of New Peradeniya Estate, who considers that students holding the full certificate of the school are competent to take charge of the books of an estate. We have been fortunate in securing as lecturer in Accounts one who is not only actually engaged in keeping Estate Books, but has also proved successful as a teacher.

The Acting Manager, Experiment Station, Peradeniya, conducted the instruction in Planting ; and the Curator, Royal Botanic Gardens, in Horticulture. The rest of the instruction was conducted by the School Staff.

In practical Chemistry, classes were conducted by arrangement in the laboratories of Trinity College, Kandy. The work was however greatly impeded by the difficulty in obtaining sufficient apparatus and chemicals owing to the war.

In January, 1919, a trip was arranged to Anuradhapura for the study of dry zone cultivation under irrigation. The students were given two whole days, one day at the Anuradhapura Experiment Station and one day for the surrounding district. The essays submitted after the trip showed that students had on the whole found sound conclusions.

The class consisted of 30 students drawn from the following Provinces : Southern Province 12, Western 9, Central 3, Northern 3, North-Western 1, Sabaragamuwa 1, Uva 1. There were 22 Singhalese students, 4 Tamils, 3 Burghers and 1 Malay. Of them, one withdrew at the close of the first session ; one died during the first vacation ; one was called on to resign in December, 1917 ; and one was permitted at the close of the first year to come up for his second year in May, 1919, owing to financial difficulties. Twenty six students completed the course satisfactorily, with an attendance of over 90 per cent. on the whole course, except in 3 cases : two owing to prolonged illness at home, and one owing to absence on Military duty.

All students resided in the school hostels under adequate supervision. The tone of the hostels was high and the health good.

The Students' Council, elected by the student body from among themselves, did good work in safeguarding the interests of the school against

factions or class prejudices, in organising student activities, and in assisting in the maintenance of good order and discipline at work, in hostels and on outings.

The third number of "The Peradeniyan" was almost entirely the work of this class. In the Students' Debating Society, much good work was done during the first year ; in the second year, the Society suffered from the pressure of the regular studies. In sports, the class made a big advance in the Tennis Club, raising it to a high pitch of effieciency ; "volley ball" was also added to the school games ; the football team was good, but little football was played owing to want of grounds or practice ; much cricket was played, but the team play was poor for want of practice. As a rule the students had too much field work to allow them to give a great deal of energy to sports.

Examinations were held at the close of each session : sessional examinations in September 1917 and September 1918 ; an examination on the first year in March, 1918 ; and an examination on the whole course in March, 1919. During the course, notes of all lectures and classes were checked weekly by lecturers and demonstrators—the marks so awarded being considered side by side with examination results.

The results of the course were satisfactory. Of the 26 students who completed the course, 22 have been awaded full certificates, 2 certificates excluding Estate Accounts, and one a partial certificate. These results were notified in the "Government Gazette," No. 7,011 for 16–5–19, p. 1,198. Two gold medals and ten prizes of books were offered for competition by leading Ceylonese Agriculturists. The award of a few scholarships for further study at Poona to the most promising students is under consideration. The certificates and prizes have been awarded as follows :—

* CERTIFICATES.

CLASS 1.—Joseph Anthony Alles
Quaten Charles Fernando
Nelson Senaratne
John Karl van Buuren
Graham Wickremesekera

CLASS 2.—Velandy Aiappen
Arthur Bartholomew Attygalle
Bertram George Buultjens (excluding Estate Accounts)
Kariawasan Bovithananthrige Valentine de Silva
Dikwella Patabendige Peter de Silva
Peter de Silva
Charles Henry Jayasingha
Jayamahamudalige Don Nicholas

PASS.—Tikiri Banda Beddewela
Kahingala Samson de Silva
Eric Daniel Fernando Jayasuriya
Wilfred Perera Karannagoda (excluding Estate Accounts)
Handinnapola Appuhamilage Piyatissa Perera
Henry Pussegoda
Sinnatamby Thurai Raja
Walter Herbert Rajapakse
George de Alvis Seneviratne
Herbert Nasadurai Solomons
David Thomas Jayawickrema Weerasuriya

PARTIAL CERTIFICATE (and excluding Estate Accounts).—
Rusdeen Ibrahim Jainudeen

* *N. B.*—Names in Lists are in alphabetical order.

MEDALS.

"THE RAJAPAKSE GOLD MEDAL," for the best all-round student of the course, presented by Mudaliyar A. E. Rajapakse, awarded to Graham Wickremesekera.

"THE SALGADO GOLD MEDAL," for fieldwork, presented by R. Salgado Esq., awarded to Nelson Senaratne.

PRIZES.

FOR AGRICULTURE :

1st.—"THE DE SOYSA PRIZE," presented by A. J. R. de Soysa Esq., awarded to Nelson Senaratne.

2nd.—"THE MARTIN PRIZE," presented by N. J. Martin Esq., awarded to Graham Wickremesekera.

FOR AGRICULTURAL BOTANY :

1st.—"THE SENANAYAKE PRIZE," presented by F. R. Senanayake Esq., awarded to Joseph Anthony Alles.

2nd.—"THE PANDITASEKERA PRIZE," presented by Graham Panditasekera Esq., awarded to Graham Wickremesekera.

FOR AGRICULTURAL ZOOLOGY :

1st.—"THE DIAS BANDARANAIKE PRIZE," presented by Sir Solomon Dias Bandaranaike, awarded to John Karl van Buuren.

2nd.—"THE DE SILVA PRIZE," presented by W. A. de Silva Esq., awarded to Charles Henry Jayasingha.

FOR AGRICULTURAL CHEMISTRY :

1st.—"THE FERNANDO PRIZE," presented by the Hon. Dr. H. M. Fernando, awarded to Nelson Senaratne.

2nd.—"THE NAMASIVAYAM PRIZE," presented by C. Namasivayam Esq., awarded to John Karl van Buuren.

FOR AGRICULTURAL ECONOMICS :

1st.—"THE DE MEL PRIZE," presented by H. L. de Mel C.B.E., Esq., awarded to Quaten Charles Fernando.

2nd.—"THE WIJEYSEKERA PRIZE," presented by Messrs Wijeyesekera & Co., awarded to Peter de Silva.

COURSE FOR SINHALESE TEACHERS, 1918.

In January, 1918, a class of 14 Sinhalese Teachers was admitted for a one year's course of instruction consisting of three terms : the first from January to March ; the second running parallel with the first session of the school year from May to September ; and the third covering November and December. These teachers were selected by the Department of Education and came from village schools : 9 from Government Vernacular Boys' Schools ; three from the Vernacular Schools of the Roman Catholic Mission ; and two from Buddhist Schools. They were drawn from six Provinces and nine districts of the Colony : Western Province, Kalutara Dt. 4, Colombo Dt. 3 ; Southern Province, Galle Dt. 1, Matara Dt. 2 ; Sabaragamuwa, Ratnapura Dt. 1 ; Uva, 1 ; North-Western, Kurunegala Dt. 1 ; and Central, Kandy Dt. 1.

Instruction was given throughout in Sinhalese and covered the syllabus of the first year as detailed in the School Prospectus, special attention being paid to village cultivation. The class was also given practice in teaching the subjects studied. Examinations were held at the close of each term, with

one final examination in December. Notebooks were kept and checked weekly as in the English class. One complete session's plotwork was done. Terminal and Final reports were furnished to the Department of Education with regard to work, conduct and attendance.

In May, 1918. Mr. T. B. Dumbukala, Native Writer, Kegalle Kachcheri, was admitted for a three-month part-course and included for this period in the Sinhalese Teachers' Class. In July, at the conclusion of his term, he was awarded a Part-Course Testimonial showing satisfactory attendance and progress.

All fourteen teachers who took the course completed it satisfactorily and passed the final examination. The attendance was good,—one with 100 per cent, 10 with 95% and over, two with 92%, and one owing to prolonged illness at home, 84%. Four Medals were offered for competition: one silver and one bronze by the Department of Education, one bronze by the Vicar-General, R. C. Mission, and one bronze by Mr. W. A. de Silva, General Manager of Buddhist Schools. In recognition of the creditable work of the Rev. Br. John Joseph, a special book prize was presented to him by the Director of Agriculture. Mr. K. B. Ekanayake Rambukwella was specially mentioned for teaching ability, and Mr. M. D. Saineris recommended to the General Manager, Buddhist Schools, for School Garden work. All the Government Teachers admitted were untrained and on the results of the course, two were selected by the Director of Education for admission to the Government Training College.

During their course, teachers resided in a furnished hostel provided for them. They made their own feeding arrangements. They received their salaries without intermission from their respective employers. The hostel was regularly inspected and was found always clean. The health and discipline in the hostel was good throughout. Only two teachers were affected by the Influenzal Epidemic in August and recovered within one week. The average age of the men was 27 years, the youngest being 17 and the oldest 44.

The results of the course were published in the "Government Gazette" for 14th March and 4th April, 1919. The following were the awards:—

CERTIFICATES AND PRIZES.

Teachers from Government Schools.—

Dissanayake Mudianselage Dingiri Banda
Ekanayake Mudianselage Kiribanda Rambukwella—Bronze Medal
Don Harmanis Karawita
Don Robert Manamperi
Don Carolis de Silva Matangaweera
Halawatuge Syprianu Perera
Panadure Warnadeeptiya Kurukulasuriya Cornelis Rodrigo
Weerakoon Aratchilage Baby Singho Silva—Bronze Medal
Theodore Wickremenayake

Teachers from Roman Catholic Schools.—

Rev. Brother John Joseph, F. B.—Book Prize
Warnakulasuriya Thomas Fernando—Bronze Medal
Kothugoda Mahavidanelage Girigoris Perera

Teachers from Buddhist Schools.—

Withanage Don Leyaris
Matara Aratchige Don Saineris—Silver Medal.

ST. L. H. DE ZYLVA,
Registrar, School of Tropical Agriculture.

Peradeniya, 20th May, 1919.

PLANT PESTS & DISEASES.

BROWN BAST.

(Department of Agriculture, Ceylon.—Leaflet No. 12.)

BROWN BAST is a disease which attacks the cortex of the rubber tree (Hevea), practically always on tapped trees. Instances of its occurrence on untapped trees have been recorded, but they appear to be very rare.

The first symptom of the disease is that the tree becomes "dry," the tapping cut ceasing to yield latex. Sometimes only part of the cut goes dry, and in such cases the latex often coagulates, when it first meets the dry part and blocks the cut, so that the latex which exudes later, runs down the stem instead of flowing down the cut to the vertical channel.

Examination of the affected cut shows that the part which is not yielding latex is grayish-yellow, and dotted with pale-brown, or brownish-yellow spots and streaks. It may also be somewhat sodden and watery, and exude a watery fluid when pricked. In well-defined cases, a continuous brownish line is found running along the cut very near the cambium. Behind this line the cortex still yields latex, and if it is pricked, latex will issue from this inner layer; hence the fact that a tree yields latex when pricked is not evidence that it is not attacked by Brown Bast. This latex, however, lies too deep, as a rule, to be obtained by ordinary tapping. Brown Bast should be suspected, if the cooly has to tap deeper than usual to obtain latex.

When the cortex beneath the tapping cut is scraped or pared away, it is found to be yellowish-gray, with grayish streaks and patches, and, here and there, red-brown streaks spots. No latex exudes until the scraping reaches to about two millimetres from the cambium.

The disease may begin at or below the tapping cut, or at the collar. In Ceylon it appears that it most usually begins below the tapping cut, and that the cooly cuts into the diseased patch as tapping proceeds downwards.

If left untreated, the disease may take either of two courses: In the one case all the diseased tissue external to the continuous brown line dries up and is cut off as a thick, usually hard, scale, leaving only a thin layer of laticiferous cortex, one or two millimetres thick, overlying the cambium. When the scale is prized off, the underlying layer appears to be healthy, but on scraping it, one finds that it is speckled internally. Subsequently, as it grows in thickness, it develops nodules, and the tree becomes untappable. The dead scales are at first usually very hard and brittle, but they become soft and friable later.

In the other case no dead scale is formed, but the nodules are produced in or just beneath the diseased cortex.

The final result of an attack of Brown Bast is the production of nodules It does not, however, follow that all nodules are the result of Brown Bast.

Nodules are formed round abnormal regions in the cortex. One of the causes of such abnormal regions is the disease known as Brown Bast. Hence nodules succeed an attack of Brown Bast. They are a consequence, or a secondary feature, of Brown Bast, although, if it were not for their development, the disease would not be so serious.

Brown Bast may begin at the collar, or in the lower part of the stem, and extend downwards along the tap root for a length of two feet or more, and also along the lateral roots. It is often confined to the part of the circumference which is being tapped, and usually does not cross the vertical channel.

There are no indications of the disease in its earliest stages. Sometimes the latex becomes very thick and coagulates on the cut. The first indication is usually the stoppage of the flow of latex : but this should not be accepted as a sign of Brown Bast, unless the cortex is discoloured. After scales have formed, they may crack longitudinally, but, as a rule, they do not fall off.

Three methods of treatment have been adopted for Brown Bast : They all have the same aims, viz., the removal, or destruction, of the diseased cortex to such a depth that any diseased tissue is destroyed and the formation of nodules prevented.

STRIPPING.

This method is officially recommended in Malaya. The whole of the affected cortex is stripped off, down to the wood.

Ascertain by light scraping how far the disease extends. With a sharp knife isolate this area with vertical and horizontal cuts, which extend to the cambium, including a margin about one inch wide of healthy tissue.

Shave the isolated area to about half the thickness of the cortex, collecting and burning all shavings. Carefully lever up the lower edge with a knife, taking care to press on the cambium as little as possible, and then take hold of the free edge and peel off the whole of the shaved cortex.

The stripped surface must not be touched, nor exposed to direct sunlight, nor to rain. Hence the operator should work under the shelter of a screen, and the stripped surface must be protected from sunlight and rain by cadjan or other screens.

Various methods of screening the stripped surface are in use : Whatever screen is used, it must not touch the stripped surface. Cadjan screens, or grass screens braced with bamboo, about three feet by two feet, are convenient. Two of these should be leant overlapping against the tree, with the lower edge on the ground about a foot from the trunk and tied to the stem by a cord round the top. To prevent rain water running down the stem over the stripped surface, a piece of cloth, dipped in paraffin wax, is placed round the junction of the screen with the tree, where it should adhere by means of the wax. It is necessary, for good renewal, to admit light, but not direct sunlight. Hence a third screen is laid against the tree, beneath the other two, and is withdrawn daily, to admit light, for a few hours.

White wax cloth aprons protect the stripped surface and admit light but are expensive.

In about ten days, the stripped area will be covered with a layer of renewed bark, and the screen may then be removed.

Stripping cannot be done when the tree is wintering, and it should not be done during dry weather or heavy rains.

SCRAPING.

The diseased cortex is shaved until latex begins to exude, and is then painted with Brunolinum Plantarium. As the scraping will, in general, leave some of the diseased tissue remaining, the Brunolinum should be used as strong as possible. The strength which can be used without causing wounds must be determined by trial ; estates apparently differ in this respect. Twenty per cent. should be tried first. If this causes wounds when applied immediately after scraping, application on the day after scraping should be tried. If the twenty per cent. solution does not cause wounds, the strength should be increased. Fifty per cent. solution has been used without injury.

When the cortex dies back after scraping and application of Brunolinum, it does not necessarily follow that the death of the cortex is due to the Brunolinum. One or two trees should be treated by scraping only, to see what happens when the Brunolinum is not applied. It must also be borne in mind that it will not be possible in all cases to make a diseased tree "as good as new."

TARRING.

The following method has been reported to give favourable results in Java :—

The extent of the diseased patch is ascertained by high scraping, and it is then isolated by deep horizontal and vertical channels, including a margin of an inch or two of healthy bark. The patch is then shaved to half the thickness of the cortex, and painted with hot coal tar, heated until it begins to bubble.

If the disease extends into the renewing cortex, this should have the outer brown layer only removed, and then tarred. To avoid wounds, cold tar should be used for renewing bark.

In cases where a thick brown scale has formed, the scale should be prized off. If the stripping method is used, the underlying layer is stripped in the usual way ; but if scraping methods are being used, this layer should be treated with Brunolinum, fifty per cent. if possible, without scraping,

In old cases, where nodules have already formed, the nodules should be cut out in the usual manner, and the wounds painted with twenty per cent. Brunolinum Plantarium, or tarred. In such cases wounds will inevitably be caused, where the nodules have become united to the wood.

The whole of the area affected with Brown Bast must be treated, including the tap root and the lateral roots. Where the roots have been treated, the holes must be left open and drained so that water does not lodge against the treated patches. If they can be spared, trees which are badly affected on the roots, should be cut out.

T. PETCH,
Botanist & Mycologist.

February, 1919.

TEA TORTRIX.

PRELIMINARY REPORT ON THE SPRAYING EXPERIMENTS.

The endeavour of the Tortrix Investigation has been to find a practically useful wash which will kill the Tortrix and make the tea bushes distasteful to the insect; the proposed scheme of spraying is part of the remedial and preventive measures suggested in Bulletin 40; the main suggestion was to have a series of Wind Belts or Tortrix Flight Breaks of leguminous trees protecting those ridges exposed to the South-West Monsoon, which is responsible for the wholesale distribution of the pest. These flight breaks may be either Dadaps, Grevilleas, Acacias or Albizzias according to the growing capacity of the plants in the particular districts; or two adjacent rows of tea allowed to grow into seed-bearers. These flight breaks were the main scheme of prevention, for they will check the distribution of the pest, insure the plants to some extent from infection from his neighbour and will prove a local breeding ground for the pest. Let the pest come and establish itself in the flight breaks, and it will be simple to kill it out cheaply with sprays.

When these flight breaks are in use, tea must be protected from attack emanating from the flight breaks, for there is a big chance that after overcrowding in the flight breaks, the insect will attack the adjacent tea.

The investigation has been established in Maskeliya for five months experimenting, to prove the efficiency of a particular chemical which may be based on tea with no harmful effect to the marketable product or on the flushing of the bush, but which will kill the insect and make the bush distasteful to it. As the investigation was satisfied by preliminary experiments and previous experience of the chemical with a similar tortrix, that the wash would kill the insect, the Maskeliya experiments were instituted to prove beyond doubt that the application of the chemical had no deleterious effect upon the flushing capacity of the bush or upon the made tea.

Before explaining these experiments, I would point out how useful such a wash will be in the general scheme of prevention and remedy. Any local outbreaks of tortrix in the tea can be checked before they assume large proportions; on the emergence of the pest from the flight breaks, the surrounding tea can be made distasteful to it, and it can be killed or driven back to the flight breaks until such time as these can be sprayed. Such artificial measures will tend to reduce the insect down to the parasite control.

The area chosen for the experiments is typical of those South-West aspects so subject to attack. It stands at an elevation of 4,300 feet, it is a high bluff absolutely exposed to the whole valley. One might figure the valley as a high funnel with the experimental area at the neck of the funnel. The reasons why this station was selected are:—

1. Because it faces South-West and is exposed to attack.

2. It is old tea (coming into pruning in January) which constitutes a perfect harbourage for tortrix, and from which it is the most difficult to exterminate.

3. Being situated as it is far from and high above any ravine, the all important item of water transport is faced. (If there is one item likely

to condemn a scheme of spraying, it is the question of water transport, and on this area, I do not think many more difficult examples could be fouud. The ground is very steep far above a service of water, and in face of these difficulties, the investigation has had to worry through a severe drought (February, March and April) ·66 in. in 41 consecutive days.

4. Being old and thick tea, more solution is required and the difficulty of wetting every leaf of every bush make the whole experiment one of the most severe. Costs will be found to be high, but it must be remembered the experiments typify every difficulty and, generally speaking, it should never be necessary to spray such old tea.

The acre is divided into 18 equal plots, six of these plots are devoted to No. 1 wash, six to No. 2 wash and six are untreated or control plots. The plan of the experimental area shows the distribution of treated and control plots.

For a clear consideration of the effect of the washes in comparison to the controls, I may state that the controls possess 36 bushes more than No. 1 plots, and 16 bushes more than No. 2 plots. This fact would show a likelihood of the controls giving a greater yield than the treated areas. By the application of the probable error, the results to date show that the yields of the controls are considerably less than the treated plots, i.e., 11·5 per cent. less than plots treated with No. 2 wash and 6·2 per cent. less than those treated with No. 1 wash.

As to the actual condition of the treated plots, I can but refer you to the opinion of planters who have examined them. MR. FINCH NOYES, Chairman of the Maskeliya Planters' Association examined the experiments in every detail and gave it as his direct opinion that the treated plots are in far better condition than the controls.

This is due in all probability to the fact that tortrix is present in the controls, but cannot establish itself in the treated plots, also numerous other insects such as Aphids (Ceylonia theacola) and Thrips and Nettle Grubs do not exist in the treated plots. The point is, the controls represent ordinary estate bushes with their innumerable insects (pests or otherwise) *while the treated plots re insect free.*

That the treatment in no way injures the bush, but tends to improve its condition by making the bushes uninhabitable to insects is proved. The question of the effect of the washes upon the marketable product is now to be considered.

After each spraying, samples of tea made from the flush from treated and control plots have been submitted to fifteen of the senior firms of tea experts. I have to date 135 reports. These reports, in complete ignorance of which teas are treated, tell me whether there is any taint present likely to reduce the value of the tea as a marketable product.

Of these 135 reports, 12 report a taint in No. 1; 5 a taint in No. 2; and 41 a taint in the untreated. 65 times has the tea treated with No. 2 wash been the best, with good quality, fine flavour and a standout cup. 40 times No. 1 has been the best, and 30 times No. 0. On a close analysis of these reports, it is seen that No. 2 wash gives the preferable tea, and that it materially improves the flavour.

There is no doubt that No. 2 wash improves the tea and tea from bushes washed with No. 1 solution have a higher place in the opinion of experts than ordinary untreated tea.

The question of costs: Spraying with the Knapsack sprayers cost during the experiment Rs. 11·18½ per acre inclusive of manufacture, labour and a water transport.

To spray with No. 2 wash costs Rs. 13·07½ per acre inclusive of labour and water transport, etc. These prices are excessive ; but materials alone are costing, in the case of No. 1 wash Rs. 9·58½ per acre and with No. 2 wash Rs. 11·47½ per acre. The materials and their transport are expensive, but they will not always be so. If larger quantities of materials were ordered even now, costs could be reduced by one-third.

In further considering the costs, it must not be forgotten that the area chosen presents every difficulty, old and big bushes—demanding the maximum of solution and time in spraying—and difficult water transport. Every solution has been made on the estate under estate conditions and with estate difficulties.

Water transport costs 80 cents per acre, because a small reservoir—a hole in the ground measuring 6 feet by 3 feet—has been made and previous to spraying two coolies fill that whole with water in half-a-day.

I have already stated it should never be necessary to spray in old bushes as those of the experiment, for, should the pest become established in it, and thus threaten neighbouring fields, it would be cheaper and safer to prune it before its time, and burn the prunings. In the case of spraying bushes six or eight months from pruning, the cost could easily be halved, for material and time will be saved. For practical purposes, I would quote the costs for to-day of Rs. 5·00 per acre for No. 1 wash and Rs. 6·53 per acre for No. 2 wash, inclusive of materials, labour and water transport.

The summary is as follows :—

1. The washes in no way injure the bushes.
2. Insects do not exist in the treated plots.
3. The yield of the treated plots is greater than that of the untreated.
4. No 2 wash materially improves the sample by bringing out the flavour.
5. Costs of spraying are high, but the experiments combine every difficulty likely to be met with, and in practice should never exceed half the costs stated.
6. Rain has no effect on the washes, once they have dried on the leaves.
7. Difficulties of water transport may be materially lessened by sinking a small reservoir in the area to be treated.
8. The washes may be simply manufactured on any estate.

The composition of the washes is as follows :—

No. 1 Wash = 1 oz. Lead Chromate per 4 gallons of water.

No. 2 Wash = 1 oz. Lead Chromate
1 pint Rosin Compound } per 4 gallons of water.
(2 lb. Rosin and 1 lb. Sodium Carbonate in 3 gallons of water.)

N. K. JARDINE,
Entomologist
for Tea Tortrix Investigation.

May 8th, 1919.

DISEASES OF RUBBER PLANTATIONS.

R. J. H. HOPE, R.E.

It is recognised throughout the whole world that Great Britain possesses in its Tropical plantations a most valuable asset: The greater part of the planted rubber area lies in British Possessions, and it must also be observed that a fair proportion of the area under rubber in the Dutch Colonies is owned by British investors and controlled by companies registered in this country. The capitalised value of rubber plantations exceeds £15,000,000 sterling, and already the areas in bearing are capable of yielding a grand total of 250,000 tons for the current year. These plain facts demonstrate to all, the enormous asset which this country possesses, and throw a responsibility on the shoulders of every investor, director, and manager. It is an obvious duty and responsibility (not transferable) to maintain such a valuable asset in a sound, healthy condition.

It so happens that Hevea Brasiliensis can only be grown in hot, moist climates; unfortunately extensions have taken place over very wide areas on which there are now very few forms of vegetation other than this ideal plant for cultivation. The existence of huge stretches of the same species renders the individual plants liable to the attacks of dangerous fungi. A fungus once it has adapted itself to its host, will always be certain of finding plenty of food from the same species, and a continuous life is therefore assured to any fungus, if no attempt is made to destroy it.

DISEASES ALREADY KNOWN.

During the last few years without exception every island or territory on which Hevea Brasiliensis is cultivated, has reported the existence of parasitic fungi capable of doing enormous damage in a very short time. The fungus which has probably caused most trouble throughout the area is *Phytophthôra faberi*.—Maubl., and possibly another species of the same genus. In different countries the effect of Phytophthora has been variously described, the names: "Black Thread," "Stripe Canker," "Bark Rot," "Bark Canker," "Black Line Canker" and others, having been applied to affections of the bark specifically attributed to one of more species of this devastating fungus. The bark of rubber trees is also affected with a disease commonly described as "Brown Bast," which unfortunately, was at one time referred to as "Patch Canker." There is also another most serious disease known as the "Pink Disease," which particularly affects the angles formed by branches and also the bark on other parts of the tree.

Bark diseases of a somewhat similar type have been known to affect cacao plants throughout the Tropics, and, guided by the results of experiments with bark diseases on cacao, many planters believe that the only effective remedy for such diseases is the free use of the knife. Now it so happens that the cacao tree may have its stem hacked about without the fruit crop—the source of revenue—being materially affected. With rubber trees the very opposite is the case. *The bark is the mother of rubber.* If it has to be destroyed by the process of excision, a future source of rubber is lost to the estate. It is admitted and, in the interests of the industry, recommended, that in severe cases the diseased bark should be cut away and burnt. But, on the other hand, knowing that the bark is the one tissue to preserve, one must aim at finding some re-agent which will kill the fungus without destroying the whole of the bark from which rubber is obtained. It was necesssary, therefore, to find a fungicide, which would kill these dangerous fungi and fulfil other desirable qualities.

CLAIMS OF BRUNOLINUM PLANTARIUM AS A FUNGICIDE.

It is found that Brunolinum Plantarium, which has now been in use some years, is a mixture which comprises the following desirable features :—

1. This re-agent is a strong fungicide of proved value in the Tropics.
2. Brunolinum Plantarium is harmless to human beings and can be easily handled.
3. Brunolinum Plantarium does not burn the wood or the soft bark tissues.
4. Brunolinum Plantarium is so constituted as to permit of its being stored in the Tropics for a long time without undergoing deterioration.
5. Brunolinum Plantarium can be used in the neat or diluted condition daily or less frequently.
6. It is soluble in water.
7. It does not contain any ingredients which would influence coagulation of latex in the factory.
8. Brunolinum Plantarium does not contain any substances which would have an injurious effect on the finished rubber, or the scrap remaining on the cut, or its keeping properties.
9. Brunolinum Plantarium does not rapidly evaporate, but dries slowly.
10. Brunolinum Plantarium has the power of permeating through the soft tissues of the bark to varying depths according to its strength.
11. Brunolinum Plantarium is available at all times of the year.
12. Brunolinum Plantarium is cheap and procurable from the manufacturers' agents in all rubber-growing countries in large quantities.
13. As Brunolinum Plantarium is manufactured under careful laboratory supervision, it is always up to standard in efficiency and strength.

It is therefore claimed that Brunolinum Plantarium is a fungicide, which represents as near as possible the ideal aimed at by planters, managers, and directors.

EXPERT OPINION ON BRUNOLINUM PLANTARIUM.

Expert advice in the East and this country from Mycologists and Experts of repute have justified the increasing demand for its use. Mr. T. PETCH, Mycologist to the Government of Ceylon, in his Circular, No. 9, issued by the Department of Agriculture, Ceylon, states that a 5 per cent. solution of Brunolinum Plantarium prevents "Black Stripe" or "Bark Rot Canker," and that for that purpose should be applied after every tappiug during the rainy season. He furthermore states a 20 per cent. solution of Brunolinum Plantarium will actually cure "Bark Rot," and that this strength should be applied to diseased trees as soon as the disease begins and the application continued for three days after its application. PROF. PETCH recommends this treatment to be followed when the disease is active. The same authority has also stated that "undiluted Brunolinum Plantarium can be applied when scraping for Canker or Brown Bast without causing excessive injury. (*Since this report was made, Brunolinum Plantarium has been doubled in strength.*)

A series of experiments were also conducted by PROF. PERCY GROOM, D. Sc., etc., and DR. WEST in this country. These scientists first endeavoured to determine the lowest possible concentration of Brunolinum Plantarium, which would prevent the growth of various fungi on artificial culture media. The culture medium employed in the first series of experiments was a $2\frac{1}{2}$ per cent. plum agar. The Brunolinum Plantarium was used in the following strengths :—

0·005	per cent.	(by volume).
0·01	per cent.	
0·1	per cent.	
0·2	per cent.	
0·3	per cent.	

The culture containing these respective strengths of Burnolinum Plantarium were infected with a number of fungi, including the following :—

Pestalozzia quepinii
Aspergillus repens.
Fomes sp.
Rhizopus nigricans (Mucor stolonifera)
Mucor hiemalis
Penicillium glaucum.

After four weeks, these cultures were examined, and the following results were noted :—

In the cultures containing 0·005 per cent., 0·01 per cent., 0·1 per cent., fungi made luxuriant, slightly less luxuriant, and less luxuriant, but still appreciable growth of fungi, respectively. The cultures containing 0·2 per cent. and 0·3 per cent. showed no growth of fungi at all. In order to confirm these results, media containing 0·2 per cent. and 0·3 per cent. of Brunolinum Plantarium respectively were left exposed to the air for 21 days, when it was found that both remained perfectly sterile, whereas a control medium containing no Brunolinum Plantarium was infected with a variety of fungi at the end of that period.

The conclusion of outstanding importance to be drawn from these results is that 0·2 per cent. (by volume) concentration of Brunolinum Plantarium is the lowest possible concentration to prevent the growth of fungi on artificial culture media under ordinary experimental conditions. This result is of great value to every planter.

Interpreted in its practical form, it means that the strengths recommended are such as definitely to prevent the growth of the powerful parasitic fungi now affecting rubber trees.

CONCENTRATIONS OF BRUNOLINUM PLANTARIUM RECOMMENDED.

In practice the following strengths are advised :—

5 to 10 Per Cent. to Cure Bark Diseases.

2½ Per Cent. Strength to Prevent Bark Diseases & Spreading.

These strengths do not cause any injury to renewing bark. The fact that Brunolinum Plantarium not only permeates the bark and stops the spreading of the disease, but actually heals the wound, is a factor which all planters must bear in mind. In the "Times of Ceylon," October, 1916, Prof. Petch remarks that "it has proved more important to protect wood from borers and fungi than to consider the most rapid method of healing the wound." Brunolinum Plantarium does both ; a 2½ per cent. solution heals the wound and is a protection against all fungi.

PROTECTIVE COVERING.

It is essential that in case any injury to, or loss of, the bark or the wood of the tree itself, the wound should at once be treated with Brunolinum Plantarium. The exposed tissues, if not treated, are readily attacked by parasites.

Tar has been used for many years for this purpose, but Brunolinum Plantarium is more effective and cheaper. To avoid trouble, damage, and expense, only a "proved" article should be used. Mr. Petch remarks in his book : "Many of these patent liquids (now on the market) are merely waste products from coal tar with nothing to recommend them, but their smell." But Brunolinum Plantarium is recommended by Mr. Petch.

The effectiveness and efficiency of Brunolinum Plantarium is due to its combined properties of "penetration" with "surface formation."

Penetration is required to cure, surface formation and penetration to prevent disease. It is obvious that any liquid or substance having only one of these properties is useless in most cases. Tar only forms a surface covering and does not penetrate ; hence its limited effectiveness.

RECOMMENDATIONS OF MALAYAN AND SUMATRAN EXPERTS.

Further valuable information regarding fungicides is given in the issue of the MALAYAN TIN & RUBBER JOURNAL, dated 18th November, 1918. Recommendations have been made by planters in Malaya and Sumatra as to the best means of preventing the spread of bark diseases and of effecting a cure. Various disinfectants have been recommended, and the following extracts relate to the value of Brunolinum Plantarium as the result of experiments made by the scientists referred to :—

RICHARDS states : " Tapping of cuts affected must be stopped at once, and the Brunolinum painted over the surface, above and below the cut, with a brush to ensure perfect covering. Tapping may be continued after the affected tree has been rested one month. Stop again immediately any new affections, appear."

BELGRAVE states: "when recommending disinfectants for painting diseased patches, Dilute Brunolinum or some similar paint if bark not excised."

ASHPLANT, who believes that thousands of trees have been cured of bark disease by non-surgical methods, states : that " Brunolinum penetrates more deeply into diseased bark and wood than into living healthy tissues. When small wounds have been made, they can be painted with Brunolinum, but wounds an inch or more in diameter should be tarred."

These recommendations, coming as they do from experts, who have spent many years investigating diseases in Malaya and Sumatra, speak for themselves.

The manufacturers of Brunolinum Plantarium also produce a wood preserver and white ant preventive under the name of " Brunolinum," which many planters prefer to use for the prevention and cure of fungi diseases, and which is equally effective as a certain cure and preventive, provided it is employed in the correct strengths, but it is not so easy to use as it has to be first emulsified with water by using 1 lb. of soft soap to 1 gallon of " Brunolinum."

According to tests made in the Federated Malay States "*Brunolinum Plantarium is twice as strong in fungicidal properties as Brunolinum*" ; hence where ordinary " Brunolinum " is employed, double the strength recommended for Brunolinum Plantarium must be used.

ADVANTAGES CLAIMED.

The advantages claimed for Brunolinum Plantarium are :—

1. It is soluble in water, which gives (a) Concentration for shipping facilities ; (b) Dilution to any strength required ; (c) Can be used on wet or damp wood, or tissue ; (d) It is not inflammable or volatile, and can be stored for long periods without deteriorating.

2. It cures and protects against all fungoid growths and diseases.

3. It also protects against white ants and other insect pests.

4. It does not injure the scrap rubber.

5. It is fool proof ; i.e., if too much is used, no harm is done to the tree, but for economy larger percentages than those given should not be used.

6. It is manufactured by an all-English company from raw materials produced in Great Britain, with British labour, and sold by agents, who carry stocks in every rubber-producing country.—THE MALAYAN TIN & RUBBER JOURNAL, Vol. VIII, No. 7.

NOTES ON THE GENERAL TREATMENT OF FUNGUS DISEASES.

A. C. TUNSTALL, B.Sc.

Just before the war, many gardens were making arrangements for adding spraying to the general routine of tea culture and the machinery, in many cases, was indented for. Unfortunately it was then imposible to get the necessary apparatus at reasonable prices. Conditions are now improving, and it is to be hoped that it will soon be possible to obtain satisfactory machines. It is probable therefore that many planters will be turning their attention to blight treatment in the near future. In the past few years, we have added considerably to our store of information regarding the fungus blights of tea and, in the light of this knowledge, it is possible to modify the schemes proposed three or four years ago with advantage.

THE VALUE OF SPRAYING.

To begin with, it should be pointed out that spraying is only one of the ways of treating fungus blights. Unfortunately it seems to be impossible to get out of doing it, but it should be avoided as much as possible, as, under the present conditions, it is costly in both money and labour. To attempt spraying on a large scale, without considerable knowledge of the life-histories of the fungus diseases concerned, is likely to lead to disappointment and waste of money. Planters are recommended to consult this department in regard to any schemes they are carrying out. Our experiments have shown that the spray fluids in common use, although beneficial to *healthy* tea, do not cause a sufficient increase in crop to warrant their application to such tea. The spraying of tea attacked by leaf or stem diseases however is a distinctly profitable undertaking, if it is carried out with due regard to the life-histories of the fungi concerned.

THE GENERAL TREATMENT OF OUTBREAKS OF FUNGUS DISEASE.

The parasitic fungi of tea mostly live inside the tissues of the plant, and it is only at those periods of their life-history when they are exposed, as during the early stages of infection and in the fruiting period, that fungicidal fluids have any great influence on them. Spraying alone therefore cannot be expected to cure many fungus diseases which grow inside the tissues. It can be used to protect the plant from attack by coating the vulnerable portions with a fungicidal covering, but to some extent on account of the climatic conditions and largely owing to the rapidity of growth of the tea plant, this protection is only afforded for a very short time. It is mainly useful in killing the fruiting stages of the fungus and thus preventing the distribution of live spores. At the same time, such spores as are germinating on the surface of the plant organs are killed and fresh infections are thus prevented. Spraying therefore must be looked on as an aid to blight treatment, not as a panacea for all fungus diseases. By spraying, we disinfect the surface of the plants. Attempting to treat, by spraying alone, a fungus disease, which lives for the greater part of its life inside the tissues of the host plant, is just about as sensible as trying to disinfect a human habitation by spraying alone, without paying attention to bedding, clothing, etc.

THE TREATMENT OF OUTBREAKS OF DISEASE.

When an outbreak of disease occurs, every effort should be made to collect and destroy all diseased material, taking care that in so doing the disease is not distributed over a large area by careless handling of such material. The collection and destruction of diseased material should, in the case of leaf and stem diseases, be followed immediately by the application of a fungicidal spray, to disinfect the plants, and thus prevent new infections. After this treatment, a careful watch should be kept for fresh outbreaks, and the same procedure followed on their discovery. If this is done as soon as the outbreak is discovered, the disease can often be eradicated, or at any rate kept in check with little difficulty.

The climatic conditions in the tea districts are such that, if once a disease get out of hand in the growing season, it is almost impossible to check it until the cold weather. It is therefore most important to have everything connected with blight treatment ready for immediate use. Too often the spray materials are out of stock and the machines in a dirty condition, frequently with parts missing. In consequence, the work cannot be put in hand in time, and it is often necessary to spend a great deal more labour and money.

The diseases of tea may be classified as follows :—

1. Those which infect the whole plant generally.
2. Those which cause infection more or less local.

The latter may be sub-divided according to the part they most commonly attack, e. g., into leaf, stem or root disease. The above will be dealt with separately.

DISEASES WHICH CAUSE GENERAL INFECTION OF THE PLANTS.

The only certain cure for diseases which cause general infection of the plant is to remove and destroy all the infected plants. *Thyradaria tarda* is the only fungus of this kind which gives trouble in North-East India. The disease requires special conditions for infection to take place. Apparently it can only attack shoots which are dying back from other causes, such as the ends of pruned shoots. Considerable benefit would be obtained by spraying the shoots with a fungicide after pruning ; but whether it would pay to do so is another matter. In most cases the number of bushes which die out from this disease is so small that the cost of spraying would be out of proportion to their value.

LEAF DISEASES.

Until recently very little was known of the life-histories of the commoner leaf diseases of tea, but for some time, the matter has been under investigation in this department and, although the results are not ready for publication in pamphlet form, in making the following recommendations, the information gained in these investigations has been made use of.

The commonest leaf diseases are Blister, Brown and Copper Blights. These all grow inside the tissues, so they cannot be treated satisfactorily by spraying alone. Blister Blight and Copper Blight are caused by fungi which apparently confiine their attentions to tea, and infection from the jungle is not to be feared. Brown Blight on the other hand is found to be caused by one of the commonest parasitic fungi in the Tropics. Both Blister blight and

Copper Blight are diseases which attack healthy, vigorous tea, while Brown Blight is generally found on tea which is out of condition.

It is found that Brown Blight is generally present on healthy tea, but, unless the general health of the plant is below par, the fungus does not develop. The fungus can only attack young leaf, but it does not make itself obvious until the leaf has hardened. When tea has been badly attacked by Brown Blight the fungus not only attacks the leaves, but also the young stems, and will spend the cold weather in the latter, developing an abundance of spores in the early rains. These infect the young growth, and another severe attack follows should there be any drought or other adverse conditions. It is therefore desireable to clean out tea, which has been attacked by Brown Blight in the cold weather, and burn or bury in trenches all the prunings and fallen leaves. It would also be advantageous to spray the tea as soon as the first shoots develop. This protects them from infection and ensures a healthy first flush. Another spraying, after the first flush has been plucked, may be made if there are signs of a return of the disease. It is very little use trying to check a severe attack in the rainy season, except in the case of nurseries. In this case all the diseased shoots must be removed and the young leaf sprayed frequently. The older leaves do not matter, as they are immune.

In the case of Blister Blight the fungus has no resting stage, but is present in districts like Darjeeling throughout the year. The gardens should be searched thoroughly for the white blisters which, whenever found, should be removed and the infected bushes sprayed. If it develops into a bad attack, it is practically imposible to deal with it. The difficulty in Darjeeling is that the gardens are so close together that co-operation in dealing with this disease is essential to success. The fungus takes ten or eleven days from the time of infection to develop its fruits, so that it is necessary whenever an outbreak has been discovered and treated, to keep a sharp lookout for that time at least, and remove and spray wherever the blisters appear. In Darjeeling, where this disease is very bad, all nurseries and collar-pruned tea should be sprayed at frequent intervals until the shoots have grown satisfactorily.

Copper Blight is very easily confused with Brown Blight. It however frequently causes the leaves to bend over in a characteristic manner. It is usually found on vigorous healthy tea. Fortunately it requires special climatic conditions for infection. Usually attacks occur about the second flush. The fungus can survive the cold weather in dead leaves so that, where this disease is prevalent, it is most important to remove or cover deeply all dead or diseased leaves. Spraying as the first and second flushes develop is beneficial as the fungus is only capable of infecting young leaves.

STEM DISEASES.

The commonest stem disease is Red Rust. An attack of Red Rust is the result of the ill-health of the plant. It is therefore imperative to find out what is really wrong. The dead or badly-diseased shoots must be removed and the plant sprayed immediately after. If the badly-diseased portions are not removed, it takes much longer for the plants to recover and the shoots die back much further. The spraying helps the bush to recover, but the improvement is only temporary, unless the causative conditions are set right. The spraying is very useful, however, as it may save plants from dying right out.

Another common stem disease is Thread Blight: This is very easy to cure. In most cases letting in the sunlight by stick pruning is all that is

necessary. It sometimes happens, however, that the disease survives this treatment. In that case spraying should be resorted to after pruning. Solutions double the strength recommended for use in the rainy season may be used with advantage.

ROOT DISEASES.

The treatment of root diseases is quite simple. In most cases no chemicals are required. Merely dig up and burn all the diseased bushes as soon as they are found. All the little pieces of dead roots would be carefully removed from the soil. The simplest way to do this is to throw it through a piece of coarse wire-netting fixed to a strong frame. Further treatment, if necessary, can be carried out later according to the nature of the disease.

SUMMARY OF WORK REQUIRED.

The work required, in addition to the customary routine, for the general treatment of fungus diseases, may be summarised as follows :—

In cold weather :

1.—Remove and burn or bury, so deep that the first few rounds of hoeing will not turn them up, all leaves and twigs showing signs of disease.

2.—Spray with a fungicide all bushes whence diseased portions have been removed.

In the growing season :

1.—Keep a careful lookout for outbreaks of any diseases, which experience has taught, are liable to become serious.

2.—Remove and destroy all leaves or stem attacked by those diseases at once.

3.—Spray all bushes from which diseased portions have been removed, together with their immediate neighbours.

APPARATUS NECESSARY.

Every garden should be equipped with a godown with sprayers, water-carrying apparatus, spare parts, field repair outfit and chemicals ready for immediate use. Where conditions permit, it is a great advantage to have a special cart fitted with all the necessary appliances ready to proceed anywhere in the garden. This should be in charge of a special man or staff of men, whose duty it would be to keep the machinery, etc., in order and look for outbreaks of blight.

WHAT TO SPRAY WITH.

There are many spray fluids to choose from, but most of them require careful preparation. It seems practically imposible to get such solutions as Bordeaux Mixture and Lime Sulphur solutions made up satisfactorily on the garden. It is cheaper in the long run to get ready-made fluids in concentrated form, though even ready-mixed preparations are not used properly if any trouble is required in diluting them. After a great deal of observation, the writer has concluded that Lime Sulphur solution is very satisfactory for most purposes, but in cases where planters prefer copper compounds, such as Bordeaux Mixture, Burgundy Mixture ready mixed in powder form is better than the Bordeaux Paste. Both the above are available in Calcutta.

CAUSTIC SPRAY FLUIDS.

Many gardens have been using caustic spray fluids for heavy-pruned tea on a large scale. It should be pointed out that these fluids are recommended for special purposes, such as the removal of mosses and lichens. They do very little good and possibly some harm to really healthy tea. In places like Darjeeling, where the mosses and lichens are very thick, the general use of these fluids is recommended, but even then they should be only just strong enough to do the work required of them.—PLANTERS' CHRONICLE, Vol. XIV., No. 16.

INSTRUCTIONS FOR THE CONTROL OF RICE WORMS: (PRODENIA LITURA FABR.—SPODOPTERA MAURITIA BOISD).

B. ARCE.

(Plant Inspector, Philippines),

Almost every year many rice-farmers suffer great loss in their crops from the damage inflicted by the cut-worms. Sometimes the farmers cannot plant rice at the right time, especially those with no irrigation system, due to the fact that the damage is done when the rice seedlings in the seed-bed are vigorously growing and are about to be transplanted.

There are two species of cut-worms, that are commonly found in these Islands, attacking rice seedlings of lowland and upland rice plants; they are known to the common farmers as "uod sa punlang palay" in Tagalog, "uod sa humay or Tagustus" in Visayan, "Iggues ti bonobon" in Ilocano and "ulad king punlang paie" in Pampanga. These worms, which are nocturnal in habit, voraciously attack cabbages, tomatos, tobacco and other plants beside rice. In the day-time they hide under loose soil, weeds or dirt.

Their life cycles vary. That of the *Prodenia litura fabr* is from 33 to 50 days; and that of the *Spodoptera mauritia* is from 31 to 66 days in captivity through the following stages:—

Prodenia Litura Fabr.

Egg stage	...	days	3-4
Larval stage:			
First instar	...	do	3-5
Second instar	...	do	3-5
Third instar	...	do	3-4
Fourth instar	...	do	3-5
Fifth instar	...	do	4-6
Pupal stage	...	do	9-11
Adult stage	...	do	5-10
	Life cycle	days	33-50

Spodoptera Mauritia Boisd.

Egg stage	...	days	2-4
Larval stage:			
First instar	...	do	3-5
Second instar	...	do	4-6
Third instar	...	do	4-5
Fourth instar	...	do	4-7
Pupal stage	...	do	8-16
Adult stage	...	do	5-24
	Life cycle	days	31-66

The eggs are laid in masses on both surfaces of the leaves, with a covering of dense, fine, hairs and scales which are attached to them by the female moth by rubbing the tip of her abdomen over the mass of eggs. This is undoubtedly done to protect the eggs from the attacks of parasites and unfavourable climatic conditions. The egg mass is roundish in shape, and of a hairy, reddish-brown colour; it measures generally about 10 to 20 millimeters in diameter. The incubation, as shown in the tabulations, is from two to four days.

The larva is cylindrical and when newly-hatched, measures from one to one-and-a-half millimeters; it is brownish-black in colour excepting the head, which is shiny black. The *Prodenia litura* molts four times before it pupates, while the *Spodoptera mauritia* molts only three times. In every molting the

colour changes, until when full-grown, the larva is dark-green with brownish strips and lines of black spots on the dorsolateral and ventrolateral. The *Prodenia litura* has a black stripe running crosswise on the portion of the thoracic segments, while in the second and up to the fourth instar. When the larva is full grown, this stripe is transformed into a pair of heavy-black spots. The full-grown cut-worm measures about 30 to 40 millimeters in length and about 5 millimeters in width. When it is ready to pupate, it bores into the loose soil, under weeds and dirt, forming an earthern shell.

The pupa is a deep reddish-brown, measuring from 15 to 18 millimeters. The head is rounded in shape and smooth. The eyes, wings, spiracles and segments of the abdomen are well marked. The tip of the abdomen is flat and pointed. It takes from 8 to 16 days to pupate (see tabulations).

It has been noted, the breeding adults or moths in large cages, under observation, when fed with molasses, sweet fragrant sliced fruits and flowers with sweet nectar, lived from 5 to 24 days.

The moths of these two insects differ in appearance. The *Prodenia litura* is a pale-brown with whitish stripes crossing the wings and two heavy white patches set transversely on the centre and near the costal margin of the forewings. Its size is about 8 to 20 millimeters when resting.

The *Spodoptera mauritia* is a dark-brown with a pair of whitish stripes and black spots set side by side transversely on the centre of the forewings. The size is about the same as that of the *Prodenia litura*.

Relative to the control measures for those insect pests, the following recommendations are given and the farmer may select the one that he considers most practicable for use on his crop and in fields.

SPRAYING.

Rice plants which are attacked by the rice cut-worms may be sprayed with a solution of lead arsenate in the proportion of one kilo of lead arsenate to one hundred liters of water. The arsenate should first be well dissolved in a small amount of water and then more water to make one hundred liters. Spraying can be done at any time of the day, but it is better to do it before evening. The plants should be liberally sprayed. A spray-pump with a good nozzle is recommended. The solution must be stirred during spraying, so that the arsenate of lead will not settle to the bottom. This method can be used for any kind of cut-worms and biting insects attacking rice plants. Every precaution should be taken to prevent poisoning human beings or domestic animals. Lead arsenate is a deadly poison.

Sweeping with a net.—This is practical and is one of the best ways of controlling the pest, because it is inexpensive, simple and effective. It is done as follows:—

A coarse cloth bag fastened to a ring, the lower portion of which is flattened and fitted with projecting teeth about ten centimeters long and about five centimeters apart, like a rake, is used as a net to sweep the infested field. The worms brushed off from the leaves into this bag or net are then destroyed. The sweeping must be done between 6 and 9 p.m.

Submerging method.—This is applied only where there is plenty of water. After the dikes (pilapils) are repaired, the water is allowed to run in until the seed-bed is submerged. The water will force the worms to rise to the surface and float. They can be easily collected or skimmed off by means of a sieve or net. The surplus water should be drained off afterwards. Where the seedlings have grown much taller than the dikes and complete submersion is impossible, a combination of this method and the one described in the preceding paragraph will be found very effective. Care should be taken not to overflow the dikes to keep the worms from being washed over into other fields. The worms should always be collected and destroyed.—PHILIPPINE FARMER, Vol. V. No. 2.

SOILS AND MANURES.

THE COMPOSITION OF THE SOIL.

SIMPLE FACT REGARDING ITS CHEMISTRY.

Considering what an important part the soil plays in the life of the farm, it is surprising how few know much about its structure. There is no reason why this should be neglected, for the soil presents a most interesting study, and one which should be at all times profitable. It may be advanced that few have the opportunities owing to the pressing nature of their work to undertake studies of this kind, which is true enough as far as it goes, but if it results in an improved knowledge and better yields, and, consequently more money, it will be admitted that nobody can afford to neglect such investigations.

If any soil be examined that has not been disturbed by tillage operations, it will be seen to be composed of layers which are always in the same order, no matter what soil it is or where it may be. The best place in which to make an examination of a soil, is in a railway cutting, or a donga, or in any place where there is a deep opening between two portions. An examination of such a section will reveal a grass or vegetable layer about three inches deep at the top, which is generally called turf. Below this is a layer of the soil proper ranging from a few inches to a few feet or more in depth.

Below this again, in some cases, is what is called the subsoil. There are cases in which there is no subsoil at all, but on the other hand the subsoil may extend downwards to a great depth. The subsoil can be distinguished from the soil and turf by the fact of its being lighter in colour. Sometimes, in the lower portions of the subsoil, or where the subsoil is absent, immediately below the soil proper, we find rubble or broken rock mixed up with the earth. Underlying the whole is the solid rock from which the overlying soil has been formed.

These are the structural divisions of a soil. They do not all exist in every soil, but when they do occur they are always in the same order. Sometimes while the different divisions can be seen, it is impossible to find any actual line of separation between them.

Next we come to the composition of a soil, or the ingredients of which it is composed. There are five of these : viz., stones, sand, clay, lime and humus. It is on the preparation of these constituent parts that the farmer bases his opinion of the value of a soil, so far as its mechanical condition is concerned, for agricultural purposes. It forms, in fact, the basis of classification of soils for the purposes of classification and description.

VARIETIES OF SOILS.

There are endless varieties of soils, but every soil can be included in one or other of the following seven classes : (1) Sandy, (2) Loamy, (3) Clayey, (4) Marly, (5) Calcareous (i.e. chalky), (6) Gravelly, (7) Humus.

The description of a soil depends upon the relative proportions of its five proximate constituents. For instance, if humus predominates, we call it a humus or peaty soil ; if sand is a large constituent we term it a sandy soil. It is scarcely necessary to point put that it is impossible to give hard-and-fast percentages of constituents for each class of soil, but we can decide upon approximate proportions which will assist us in classifying soils that come under our observation.

If the planter in the course of his wanderings will test his knowledge by estimating the character of the soil, he will find the information gained valuable, and the practice in differentiating between them very helpful.

The following percentages will be useful as representing the limits of each class : Sandy soil should contain over 90 per cent. of sand. Sandy loam should contain from 80 to 90 per cent. of sand. Loamy soil contains from 70 to 80 per cent. of sand. Clayey loam contains from 30 to 50 per cent. of clay. Clayey soil contains over 50 per cent. of clay. Marly soil contains from 5 to 20 per cent. of lime. Calcareous soil contains over 20 per cent. of lime. Humus soil contains over 5 per cent. of organic matter. These facts are worth storing up, so that when a certain treatment is recommended for a certain soil, a farmer may see at once what it is composed of.

CLAYS.

Clay comprises the sticky, plastic part of the soil. When there is too much of it, the soil is heavy. Every fertile soil must contain lime, even if only in a small proportion. Limes make stiff soils, such as clayey ones, more crumbly and friable, and is therefore added to improve the soil.

HUMUS.

Humus is the animal and vegetable matter, which, decaying, have accumulated in the soil and mixed with the mineral constituents. All fertile soils contain some humus. The terms organic and inorganic are often used in relation to the soils, and there must be many times when they puzzle the farmer striving to understand what he is reading about. The meaning of such terms can be impressed upon the mind by a very simple experiment :—

Suppose one were to take a quantity of dry soil on a shovel and heat it over a fire to a red heat, part of the soil would burn away, while a portion would remain in the shovel unaffected by the heat. The part which burns away would be the organic part, and the portion remaining, the inorganic.

The proportion burnt away in any soil would depend upon the amount of humus, or decayed organic matter present in the soil. In a peaty soil there is sometimes as much as 90 per cent. of humus, so that if a sample of such soil were burned by far the greater part of it would disappear into the air, leaving a relatively small amount of inorganic or mineral matter.

The part that disappears in the burning consists of carbon, hydrogen, oxygen, and nitrogen.

These facts are but the A B C of soil chemistry, but the knowledge of them may prevent many mistakes being made, and induce better farming practice.—SOUTH AFRICAN SUGAR JOURNAL, Vol. 3, No. 3.

THE THEORY OF FERTILIZERS.

The amount of food that may be realised from any region, depends upon two obvious factors—the area of soil and its fertility. In a new or pioneer country, land is plentiful, and the need of an increasing food supply for a growing population is met at first by enlarging the area cultivated; but sooner or later, there comes a time when further enlargement is impossible and food must be imported or else the yield of the soil must be increased by artificial means. The world has already reached the stage where in all regions of dense population the latter is imperative—a fact which should have the widest and most thorough appreciation.

Various means of increaing soil productivity are practised, but the most important gain is attained by adding certain products directly to the soil. These substances are the so-called fertilizers. A glance at the nature of soils and the chemical reactions that take place in them to produce plant-growth will make clear the part that fertilizers play in accomplishing their important function.

To begin with, soil does two things: It forms a mechanical medium for supporting and protecting the growing plant, and it supplies the plant with some of the chemical material to be built into its structure. The rest of its substance the plant obtains from the air, from moisture and from the bacteria present in the soil, although the last may be regarded as part of the soil itself.

The chemical material contributed by the soil, focuses our interest here —the calcium, the phosphorus, the sulphur, the nitrogen, the potassium, the sodium, the magnesium, the iron, and some others. These substances are not present in their elemental or simple condition, but as compounds available for transfer into the body of plants.

These elements are likewise present in the solid rocks that everywhere underlie the soil, but in combinations wholly unfitted for sustaining plant-growth. They must first be rendered suitable by the general process of natural rock decay called weathering, which mechanically reduces the solid rocks to the consisteney of soil and chemically prepares their components for the sustenance of life. The soil then becomes the laboratory in which the gases of the atmosphere, with water, and certain constituents of decayed rock are combined into the organic products, or plants, upon which human life ultimately depends.

In the normal course of events, plants spring up, live their course, and die, giving back to the atmosphere and soil the elements employed in their life cycle. Thus it is that the rank growth of the jungle is unremitting. But where plants are removed by artificial means, the balance is upset and the soil is depleted in respect of some of its essential compounds. But soil is not static; the processes of weathering are continuous, and if the plant-removal be stopped for a sufficiently long period, the deficiency will be naturally remedied by the transformation of a further quantity of needed compounds into an available or soluble condition. This result, however, cannot be waited for; in populous sections the soil must be cultivated continuously; the elements removed too rapidly must be replaced artificially, that is, by the use of fertilizers. This is an absolute, basic necessity. Fertilisers, indeed, play a more fundamental part than that of merely increasing yields and profits; no soil can be cultivated continuously without their use.

Fertilizers, moreover, have an application beyond that of making possible continuous and intensive cultivation ; by their use, many soils can be rendered fertile which are deficient in one or more essential constituents by virtue of peculiar geologic history. Thus fertilizers extend the possibilities of food production to great areas, unfitted by nature for productive yield.

These considerations of the social value of fertilizers are aside from the economic advantage of their use as leading to greater profits to the acre and greater yields to the unit of labour expended. Yet this economic advantage is the great motive force which, under existing conditions at least, must be counted upon to carry fertilizer utilization to its proper realization.

By long experience, it has been found that those elements of which the soil is most quickly depleted are nitrogen, phosphorus and potassium ; and therefore compounds of these elements are the chief ingredients of the commercial fertilizers. Calcium, in the form of lime or crushed limestone, is added with favourable results to some soils ; but this is more to counteract or neutralize a high acidity or "sourness" than to contribute a needed constituent, and since, moreover, limestone is so widely distributed that an organized industry is not necessary to supply it, this substance will not be considered in further detail in this paper. Sulphur in the elemental condition, has recently come to the front as a fertilizing material of some promise, but its use, as well as that of sulphuric acid on alkali lands, may be said to be still in an experimental stage. The fertilizer industry, therefore, as it exists at present, is concerned with the preparation of suitable compounds of nitrogen, phosporus and potash to form commercial fertilizers, which are distributed for immediate addition to the soil. The securing of an adequate supply of raw materials, and the development of a wider and more intelligent use of fertilizers, are two problems of the utmost importance, especially at the present moment when the World War endangers certain of the supplies, and at the same time necessitates an increased yield in food.—WEALTH OF INDIA, Vol. VIII. No. 3.

ERADICATION OF WEEDS BY SPRAYS AND MANURES.

WINIFRED E. BRENCHLEY, D. Sc.

(Rothamsted Experimental Station.)

The old-established ways of weed destruction by appropriate methods of cultivation were sufficient and effective in the days when labour was plentiful and the land was less heavily cropped. Of late years, however, with the progress of intensive cultivation, coupled with a constantly increasing shortage of labour, the problem has become critical, and many attempts have been made to supplement the mechnical means of eradication by more rapid chemical methods. A considerable measure of success has attended the venture, though the natural conservatism of farmers has hitherto prevented a general adoption of the new methods. This may be owing partly to the failure of many people to realise that it is possible to destroy the weeds in this way without causing injury to the crop.

The chief reason that chemical weed-killers can work successfully when applied to a growing crop lies in the fundamental difference in the habits of the majority of weeds and of such crops as cereals. The leaves of many weeds are broad and outstsnding, and are often wrinkled, so that if moisture falls on them, it is retained for a considerable time, often till it is dried up by evaporation. Cereals, on the contrary, have long, narrow, smooth leaves which grow upright and are often covered with a waxy coating or "bloom," so that the leaves do not remain wet for any length of time, as moisture cannot adhere to them. If, therefore, corrosive or poisonous substances are sprayed on to the plant, the cereals throw them off and are not injured, whereas the weeds retain them and suffer the full extent of the possible injury. This same characteristic, however, renders it impossible to treat with chemicals such broad-leaved crops as clover, trefoil, sainfoin, and serradella, as their leaves retain the injurious substance in the same way as weed leaves. With root crops, the constant cultivation that is carried on is usually sufficient to keep weeds in check, so that on arable land, as a rule, it is only cereals that are dealt with by chemical means, though copper sulphate has been used to eradicate charlock from mangolds without injury to the crop. *

These methods are not so useful on grass land, because, as the herbage consists of a mat of plants with a large total leaf surface, the chemicals are held up even by the grasses, and the amount of spray necessary to kill the weeds is sufficient to cause serious injury to the herbage itself, especially to such broad-leaved plants as clovers, which are a valuable constituent of the crop. In the majority of cases, it is not possible to apply the spray in such a way that it reaches the weeds without affecting the rest of the herbage, and in consequence the method is of but limited use on grass land.

The success of the chemical eradication of weeds depends to some extent upon the weather. It is essential that the substance employed should remain upon the leaves long enough to come into action, and, therefore, if heavy rain falls immediately after an application of liquid spray, much of the benefit is lost. Consequently it is sometimes necessary to repeat the operation if the weather breaks too soon after a dressing of the destructive agent. Dry substances would easily be blown off from dry leaves, so when these are used, it is usual to carry out the work when the leaves are wet with dew or rain, as then the stuff adheres firmly when the leaves dry.

The chemical substances used as weed-killers may be divided into two groups :—

1. Chemicals that merely destroy the weeds, and have no direct beneficial action upon the growth of the crops. These substances are usually applied in the liquid form as *sprays*.
2. Compounds that not only destroy the weeds, but also exercise a manurial action, thus directly benefiting the crop at a later date These substances are usually very finely ground *manures* and are applied as dry powders when the leaves are damp.

1. *Sprays.*—Most of these are corrosive in nature and destroy the delicate plant tissues, either killing the weeds outright or so crippling them that they cease to be active competitors of the crop. The chemicals are applied in solution, the strength varying according to circumstances. The most commonly used sprays are copper sulphate, iron sulphate, and sulphuric acid, but other substances are occasionally employed. A summary of many of the earlier spraying experiments was drawn up by H. C. LONG in 1910, † and the results of these have largely been confirmed by those set forth in the present paper.

* Holmes Chapel Coll. of Agric. (1903.)

† Long, H. C., The Destruction of Weeds by Chemical Means, KNOWLEDGE, October and November, 1910

Copper Sulphate.—Copper sulphate in solution is the most familiar of the weed-sprays used on a farm, and is generally associated with the destruction of charlock (Brassica sinapis,) though it is effective with other weeds. The rough crinkled leaf of charlock renders it very susceptible to injury and, given suitable weather, spraying nearly always makes a considerable reduction. The spray is best applied when the leaves have three or four well-developed leaves, though later applications are often effective The writer saw a farm at Godling, Notts. in which charlock had been successfully sprayed when in full flower, but this delay is not to be recommended. Various experiments have shown that a 4 or 5 per cent. solution (4 to 5 lb. copper sulphate in 10 gals. of water) is the most effective strength, about 40 to 50 gal., containing 16 to 20 lb. copper sulphate per acre being required. In all cases the quantity of liquid should be sufficient to wet the weed thoroughly. In some cases a 3 per cent. solution is strong enough, but only under specially favourable conditions. *

Copper sulphate will eradicate spurrey if it be used strong enough '50 gals. per acre of a 5 per cent. solution is effective, but a 3 per cent. solution only destroys about half the crop, allowing the other half to recover and ripen its seeds. † In the latter case the shoots at first become brown and shrivel at the tips, so that growth is checked for a time, but later on recovery sets in with many plants. Poppies are far more sensitive than spurrey as even a 2 per cent. solution injures them, and it has been suggested that two applications of a 3 per cent. solution with an interval of a few days might prove very effective in destroying them.

If a soluble manure is added to a corrosive spray, the action of the latter is sometimes accentuated, as the manure stimulates the crop and enables it to forge ahead before any weeds have a chance of recovering from the action of the spray. Corn buttercup (*Ranunculus arvensis*) is very resistant to the action of copper sulphate, as a 4½ per cent. solution has but little effect on it. In one case, however, a clearance was effected by applying a 9·9 per cent. solution of copper sulphate, with the addition of 22 lb. sodium nitrate to each 10 gals. About 35-40 per cent. of the weeds were killed or badly injured, and before the rest could recover and make much growth, the wheat had benefited by the nitrate and grown right away from the weeds.‡ Such strong applications of copper sulphate, however, are not to be advised as a rule, as they need very careful handling to avoid doing damage to the crops.

Iron Sulphate.—To a great extent this can be used as a substitute for copper sulphate, but stronger solutions of the iron salt are necessary to obtain equal results. On the Continent, iron sulphate is largely used for the destruction of charlock, 40 gals. per acre of 7 per cent. solution being most effective, especially among oat crops. In German experiments much heavier dressings have been used satisfactorily, and when 53 gals. per acre of a 22 per cent. solution were applied to infested oats not only was charlock destroyed, but the yield of oats from the treated plot was reported to be six times as heavy as that from a similar plot left untreated. In this case care was taken that the plants were quite dry before treatment, and the drastic effects on the charlock were visible within two days. § In this country the best results have been obtained with a 15 per cent. solution, that is to say, 60 lb. of iron sulphate dissolved in 40 gals. of water, per acre. The addition of molasses to

---

* Charlock, Destruction, Univ. Coll., N. Wales, Bangor Agric. Depart., Bull. 1., 1909.

† Spraying of Charlock and Spurrey, Ibid,, Bull, 11, 1908; Destruction of Spurrey in Corn, Ibid. Bull. IX. 1906.

‡ Martin, J. B., C. R. de 1' Academie d' Agriculture de France, 11., 1916, pp. 420-424.

§ Hiltner D., Praktische Blätter für Pflanzenban und Pflanzenschintz. Jan.-Feb. 1911. See Journ. Bd. Agric. XVIII., pp 41-42),

the spray is sometimes recommended, as it causes the compound to adhere more firmly to the weeds.

Iron sulphate is better than copper sulphate for eradicating poppies and corn buttercup. A 15 per cent. solution destroys the weeds and does not injure the cereal crop; for corn buttercup spraying should be done in February, and for poppies as soon as the seedlings have developed three or four leaves.

Although this spray cannot be used on broad-leaved crops growing alone, it may be safely applied when leguminous crops are associated with cereals, as the latter are the taller and, together with the larger weeds, receive the bulk of the spray, thus protecting the lower growing broad-leaved plants to a great extent.

Sulphate of iron may also be applied dry as a fine powder at the rate of 3-4 cwt. per acre * and should be broadcasted or scattered by machine in the early morning, while the leaves are still wet with dew.

Sulphuric Acid.—This is the most potent substance utilised for weed destruction, and owing to its corrosive nature needs very special precautions in handling. If properly dealt with, however, it proves effective in cases in which the more usual sprays are of little value. Sulphuric acid is one of the few sprays that has been found to clear grass land of bracken. A 5 per cent. solution causes the leaves to wilt within a few hours, and some days later the stems turn black and wither, because the acid is gradually conducted along the midrib and down the stalk, eventually reaching almost to the underground rhizomes. † A new growth springs up later but a second spraying disposes of this for the year and also weakens the plant for the future. Where the growth of bracken is dense, the canopy formed by the bracken leaves protects the underlying herbage from the harmful effect of the acid, and as the following year the fern is later in appearing, the grasses are able to get ahead earlier, resulting in an improved pasture.

On the Continent, sulphuric acid is considered a safe spray for cereals if used when the crop has only about five or six leaves. It is much used in parts of France (Lot-et-Garonne) for destroying wild radish among wheat, 90-100 gals. per acre of an 8 or 10 per cent. solution being employed. It is somewhat selective in its action, as certain weeds escape, especially wild oat (*Avena fatua*), medicks (*Medicago* sp.) and members of the lily family (as wild onion.) It is, however, deadly to most annual and biennial weeds as poppies, charlock, corn, buttercup, cornflower, wild carrot, radish, vetches and vetchlings, and it is said to be very effective in clearing these pests from badly-infested fields. ‡ For general use 60-70 gals. per acre of a 10 per cent. solution is sufficient for oats, rather less being used for barley.§

Various other Sprays.—In view of the difficulty in obtaining large quantities of copper sulphate at the present time, preliminary experiments have been made to ascertain whether *nickel sulphate* can be used as a substitute. At Rothamsted charlock plants were sprayed with 3 per cent. solutions of nickel and copper sulphate to contrast the effects. The nickel sulphate proved to be the slower in acting, but six days after spraying, young plants were dead with both sprays, while with a 6 per cent. solution, the action was rather more rapid. At a later date some very large plants just coming into flower were sprayed, but though both substances burned the leaves rather badly, neither killed the plants. Probably stronger solutions would have been necessary at this stage, but this initial test indicates that nickel sulphate may prove to be an effective substitute for copper sulphate.

---

* Bull. de Sci. Nat. d'Agric., 1909, No. 5

† Gordon, G. P., Bracken (Pteris aquilina:) Life-History and Eradication. Trans. Highland and Agric. Soc. of Scotland, XXVIII., 1916, pp. 92-106.

‡ Morettini. A., *Le Superimentali Agrarie Italiane* LXVIII., 1915. pp 693-716.

§ Jaguenaud, G. *Le Progres Agricolee Uiticole 29, 1912*, pp. 332-334.

Arsenite of soda, potassium chloride and sodium bisulphate have all been used as weed-killers, but each has some special disadvantage, which prevents it from coming into common use. *Arsenite of soda* is exceedingly poisonous to man and beast, and there is a great risk of poisoning, when the crops are used, especially if it be applied to grass land which is either fed off or cut for hay. Besides this, it is strongly held by the soil, being retained for an indefinite period in the top few inches, and if several successive applications are made, enough arsenite of soda may accumulate to hinder the germination and growth of crops sown on arable land and to exercise a harmful action on the herbage of grass land.

Potassium chloride is ruled out at the present time on the score of expense, but when prices were moderate a 20-30 per cent. solution was occasionally used for destroying charlock, as the solution shrivelled the plants up completely. The potash salt has no bad effect on the cereals, but rather works beneficially by acting as a manure in addition to destroying the weeds.

Sodium bisulphate resembles sulphuric acid in its action, and is readily and cheaply obtained in places. In parts of France, farmers can get truck loads from the powder works at the rate of 9½d. per 200 lb. free on rail.* 80 gals. per acre of 45 per cent. solution are recommended for use, but the stuff is most unpleasant to handle, though it needs less precautions than sulphuric acid.

To sum up, therefore: copper sulphate and iron sulphate are effective and simple sprays whose value has been proved by years of constant usage. Nickel sulphate, though practically unknown in this respect, offers possibilities and might repay more extended trial. Under special circumstances, sulphuric acid has much to recommend it, but the majority of other sprays are of less general value, though several of them meet the case under particular local conditions.

2. *Manures.*—The method of improving grass land by judicious artificial manuring has been gaining much ground of recent years. Incidentally this secures the reduction of the less useful plants or weeds, but this reduction is chiefly brought about by the increase in the competition of the more valuable grasses, and not by a direct poisonous action on the weeds.

During the last few years, however, attempts have been made to destroy weeds on arable land by the application of finely-ground manures, especially cyanamide and kainit, and on grass land by the use of lime, gaslime and salt, and a fair measure of success is considered to have rewarded the effort.

Calcium Cyanamide (Lime nitrogen).—Since this was introduced as a commercial manure, it has been used a good deal in Germany as a means of destroying charlock and wild radish on arable land. It is claimed that dressings of 90-135 lb. per acre are quite effective for this purpose, provided that the cyanamide is applied when the plants are small and the leaves are damp† ; thistles and poppies are injured as well as the charlock. In some cases the crops turn rather yellow for a few days after application, but they rapidly recover and make use of the extra nitrogen supplied, giving increased yields. When however, these experiments were repeated in North Wales‡ failure resulted, as a dressing of 80 and 120 lb. per acre had no permanent effect either on the charlock or the crop, and all the weeds recovered from the temporary check they received.

Kainit applied to arable land at the minimum rate of 10-11 cwt. per acre, is said to be effective in destroying charlock and many other

---

* *Feuille d' information du Ministere d' Agriculture, XXIII.*, No. 8, 1918.

† *Deut. Landw. Presse.* 4th November, 1908; 21st January, 1914. *Mitt der Deutsch. Landw. Gesell*, 20th July, 1907.

‡ Charlock Destruction, *Univ. Coll. N. Wales, Bangor, Agric. Depart. Bull. 1, 1909.*

weeds.* It needs to be very finely ground and should be dusted on the plants when they are wet with dew or rain, if possible on the morning of a fine day. For autumn-sown cereals February or March is the best time of application; for spring-sown corn the manure should be spread soon after the seeds have germinated and put out a few leaves. As kainit tends to consolidate the soil, a dressing of lime is advised on very heavy land to prevent this as far as possible.

Weeds vary in their response to kainit, as some are easily destroyed, whereas others are only slightly injured or escape damage. The chief weeds have been classified as follows :–

Weeds badly injured or destroyed by Kainit.—Charlock, wild radish, black bindweed, speedwell, chickweed, nettle, groundsel, cornflower, and mayweed.

Weeds moderately injured.—Persicaria, spurrey.

Weeds only slightly injured.—Sowthistle, fumitory, poppy, spreading orache.

Salt—Salt is occasionally useful in reducing weeds, especially on grass land. Five to six cwt. per acre applied in the spring at the time nettles are cut down, will do much to prevent this weed from springing up again strongly. A similar dressing in early April will also reduce oxeye daisy.

Thistles, however, do not seem to respond to treatment, as the effect of judicious cutting is not intensified by the application of salt. †

Lime.—This differs in its action from the foregoing, as instead of directly destroying the weeds, it makes the soil less suitable for certain of the worst pests on sown land, as spurrey, sheep sorrel, corn marigold and annual knawel. Spurrey is chiefly associated with light soils that are deficient in lime, and sheep sorrel, though it is found on both light and heavy soil, also indicates lime deficiency. Liming has been tried for the eradication of both these weeds, with indifferent success in the case of spurrey, with rather more success with sheep sorrel. When these weeds are abundant, the shortage of lime is usually very marked, and an impossibly heavy dressing would be needed to alter the balance so as to make the soil really unsuitable for weeds. An ordinary dressing, such as 1 or 2 tons of lime per acre, has no effect on spurrey, though it brings about some improvement in the soil itself, and may thus tend to suppress the weed by encouraging the competition of other plants. That is particularly the case on grass land, on which sorrel (*Rumex Acetosa*) and sheep sorrel (*Rumex Acetosella*) are usually much reduced when liming is resorted to. It is usual to apply about 30 cwt. per acre to light land ranging up to 3 tons per acre on heavy, wet soils.

Gas lime, at the rate of 20 tons per acre, has proved effective in destroying false brome or tor-grass (*Brachypodium sylvaticum*) on Down pastures.‡ The gas lime was applied in autumn, and soon killed the tor-grass (and other grasses as well). The following spring the land was harrowed and worked up to a fine tilth preparatory to sowing a mixture of good grass seeds for the provision of a strong new turf. Such a method could only be applied when the area affected is small.

Taking all things into consderation, the use of finely-ground manures as weed-killers offers possibilities, but up to the present, the results have been so uncertain and variable that it is not yet advisable to make definite recommendations for their use. Experimental work in this direction could easily be extended, as even though failure should attend the effort to destroy the weeds, the beneficial effect of the manure on the growth of the crop would offer considerable compensation.—JOURN. BD. OF AGRIC. Vol. XXV, No. 12.

* *Landw. Jahrb.* Bd. XLVI, 1914, pp. 627-657. (The destruction of weeds by Kainit is at the moment of academic interest only, the cost of substance being prohibitive.—ED.)

† Destruction of Thistles. Field experiments at *Harper Adam's Agric. Coll. Report 1908*

‡ Hutchinson, H. P., Tor-grass or False Brome and its Eradication from Down Pasture, *Journ. Bd. Agric., XIX, 1912*, pp. 648-657.

NITROGEN FIXATION BY ROOT NODULE BACTERIA.

It is now more than thirty years ago since the nitrogen-fixing power of the bacteria present in the root-nodules of leguminous plants was firmly demonstrated. During this time much of practical importance has been discovered. The bacteria have been isolated and cultivated in artificial media. Their mode of entry into the root and their power to stir up the cortical cells to abnormal growth are known ; yet even now much remains to be discovered. Of the many outstanding problems, perhaps the most important is that—often asked and never satisfactorily answered—which concerns the power of the nodule-bacteria to associate themselves with non-leguminous plants and to bestow upon them powers of nitrogen-fixation.

The discovery that sundry other plants enter habitually into association with micro-organisms and form in consequence nodule-like growths on their root system, led naturally to the suggestion that these symbiotic unions, like those occurring in leguminous plants, conferred on the plants which entertained them like powers with those enjoyed by Leguminoseæ.

Among non-leguminous nodule-producing plants are species of such genera as Alnus, Ceanothus, Cycas, Elæagnus, Myrica and Podocarpus, and sundry investigators have claimed to show that nitrogen fixation occurs in them, and have inferred that it is due to the symbiotic association. Other observers have gone further, and having discovered that certain plants habitually associate themselves with certain fungi, claim that these unions also confer on the contracting parties, the power of drawing upon the free nitrogen of the air for their supply of nitrogenous food. It is, however, doubtful whether the evidence advanced in any of these cases is as conclusive as it is in that of the Leguminoseæ. Indeed, and in the case of the non-leguminous nodule-bearing plants, the most recent evidence tends to throw doubt on the claim that they are nitrogen-fixers, or at all events justifies the demand that more rigorous proof shall be forthcoming before this view is finally accepted. Thus in his last published work* the late THOMAS J. BURRILL shows that the non-leguminous nodules differ in certain respects from those of the Leguminoseæ in that they are not caused by *Pseudomonas radicicola*, the becterium present in the root nodules of leguminous plants.

This conclusion is in disagreement with that reached by PROF. BOTTOMLEY and his co-worker who claim in the cases of Cycas, Alnus and Elæagnus to have isolated *Pseudom onas radicicola* from their nodules.

In the light of the more recent work of PROF. BURRILL, this conclusion must now be regarded as doubtful, and these plants must be rejected, at all events provisionally, from the category of nitrogen fixers.

* Is Symbiosis Possible Between League Bacteria and Non-Legume Plants ? By THOMAS J. BURRILL & ROY HANSEN. *Bull. 202 Univ of Illnois, Exp Station, 1917.*

The case of *Alnus glutinosa* is somewhat different: for notwithstanding the fact that PROF. BURRILL has shown that the nodules do not contain *Pseudomonas radicicola*, there is some experimental evidence which indicates that nitrogen fixation does actually take place in this plant. It would be well worth the while of botanists to take up this question once more and to ascertain first. whether fixation of nitrogen does occur in Alnus and other non-leguminous nodule-bearing plants; and second, what is the intensity of fixation as compared with that of leguminous plants. For apart from the purely scientific aspect of this subject, there is this most important practical aspect: that if some non-leguminous plants are in fact able to fix atmospheric nitrogen, it should not be impossible to train others to do the same beneficent work. This, indeed, was the main object of PROF. BURRILL's work. Having made the most careful study of the habits of the nitrogen-fixing bacteria, he endeavoured to induce this organism to enter into a union with non-leguminous plants as, for example, the Tomato. His experiments were not, however, crowned with success, and so far as they may be regarded as final, we have to be content with the conclusion that symbiosis between the nitrogen-fixing organism and non-leguminous plants is impossible. This conclusion is in general harmony with the facts discovered by PROF. BURRILL with respect to what may be called the catholicity of infectiveness of the nodule organism.

Although *Pseudomonas radicicola* must be regarded as one species, it forms a series of biological races, each of which is capable of infecting a restricted number of leguminous genera. From BURRILL's researches, it appears that some eleven races of *P. radicicola* may be isolated. Of these, one race confines its activities to species of Trifolium, and can transfer itself from one of these species to another, for example, from Mammoth Red Clover to Alsike, Crimson Egyptian, White or Cow-clover.

Another race is more catholic and may infect species of Sweet Clover (Melilotus), Medicago (Alfalfa, etc.), or Trigonella. A third race is common to no fewer than eight genera of legumes: Vigna, Cassia, Arachis, Lespedeza, Mucuna, Desmodium, Acacia and Genista. A fourth race is competent to infect Pisum, Vicia, Lens (Lentil) and Lathyrus, whereas a fifth race confines its attention to the Soy Bean. Similarly, Phaseolus enjoys the exclusive use of a sixth race of *Pseudomonas*, whereas the Lupine and one other genus share the favours of yet another race of the nodule organism. The Hog Pea Nut (Amorpha canescens), the trailing Wild Bean (Strophostyles helvola), and the common Locust (*Robinia Pseudacacia*) have each a race of their own.

From these facts, it must be concluded that the conditions which lay a plant open to infection are highly specialised—that the gate by which infecting organisms enter the plant is straight and the way narrow. The problem that awaits solution is this: Can man succeed in doing what Nature has apparently failed to accomplish, i.e., train plants and nitrogen-fixing bacteria so to accommodate themselves to one another as to admit of a symbiotic union, as a result of which every cultivated plant may, "without sweat or endeavour" in the shape of added nitrogen-fertilizer, make use of the atmospheric nitrogen as a source of food supply?—GARDENER'S CHRONICLE.—Vol. LXV. No, 1682.

GENERAL.

BOTANIC GARDENS, CEYLON.

(Extracts from the Bi-Monthly Report of the Superintendent of Botanic Gardens, January–February, 1919.)

PERADENIYA GARDENS.

H. E. THE GOVERNOR accompanied by the HON. ROBERT TREFUSIS, P.S., paid an official visit to the Gardens on January 9th.

The principal work has been watering, clearing, shading and general routine. Severe drought combined with strong East winds prevailed throughout February and the greater part of January, and all tender plants were badly affected. No rain fell in February and only 1·57 inches in January, the greater part of which (1·10 in.) was on one day (Jan. 28th.) Watering the plants could only be carried out in a sparing manner, owing to the very small quantity of water coming through the pipe, which was damaged in December, 1918, at the intake for a considerable length.

A further extension of the ground under Guinea grass on the East river bank has been put in hand, the ground being cleared and dug preparatory to planting, when suitable weather sets in. Weeding of the existing Guinea grass was carried out in February.

The group of Plumeria trees behind the Fernery, planted to form an enclosed orchid-garden, were thinned out by about 50 per cent. It has been found that orchids do not thrive on these trees.

Fencing and shading young plants in Arboretum etc., was begun early in January and continued till the beginning of February.

Rooting out old tree stumps in the Arboretum and levelling was carried on during the month of February.

The deep ditch passing by the side of the Kola plot in S. Garden has been cleared and bricked along the bottom.

An old tree of Schleichera trijuga, which for many years was a familiar object at the Junction of the Main Drive with Trimen Drive, having become badly decayed and dangerous, had to be cut down and removed.

The coconut arbour has been re-thatched with cadjans.

Museum.—The work in the Museum has been chiefly revising and re-writing labels, much of which is urgently needed. All the fibres have been compactly arranged together. One almirah has been set apart for a named collection of palm seed, and another for a collection of remarkable seed of fruit likely to be of value as curios or for ornament. Two very fine specimens of Bauhinia anguina stems, obtained from the Gardens, have been placed against pillars and labelled.

HAKGALA GARDENS.

The principal work here has been top-dressing, rolling, etc., of the new lawns, watering borders, etc., repairing and gravelling roads.

(The Curator's Report is as follows):—

New Lawns.—These have been top-dressed and kept rolled during the two months, and are coming on as well as can be expected owing to the dry weather.

Drives & Paths.—These have been gravelled and repaired when necessary. The Anthericum edgings along the drive have been renewed and the drains attended to.

Banks.—The foot of the bank opposite Oak plot on the side of lower Drive has been paved and the bank attended to.

Fernery.—All paths have been put in order and the beds and borders pointed over and kept watered.

Azaleas.—The following received from Japan have been planted out in the borders near the present Azalea collection :—

> Azalea murasaki-riukiu, A. Omurasaki, A. Hatsugiri; A. Ledifolium var, lencanthum, A. Schilippenbachii; A. Kirishima; and also 29 plants from the Gardens.

Rose Garden.—Several plants have been layered and 15 kinds planted out.

Loranthus.—The removal of this from the trees has been continued.

Oxalis.—About 40 bushels of bulbs and leaves have been removed from beds and borders during the two months.

Fruit plot.—This has been weeded and the plants forked round and mulched.

Acacia & Eucalyptus collections.—Index sheets of these have been completed and sent to Peradeniya and specimens collected and pressed. All the trees in the Eucalyptus collection have been labelled. The Acacia mollissima plot above Camphor plantation has been weeded.

Cupressus funebis.—Seeds have been collected from the tree below plant sheds and sown.

The weather.—The number of inches of rain recorded during January was 5·22 and for February 0·93, compared to 11·51 inches and 0·44 inches respectively for the same period last year. The greatest rainfall for any 24 hours in January was 1·24 in. (from 19th to 20th) and in February 0·49 (from 27th to 28th). The amount of rain recorded for the first two months in the year has been 6·15 inches, compared to 11·95 inches for the same period last year.

NUWARA ELIYA EXPERIMENT GARDEN.

The levelling and turfing of the lawn near the tennis court has been continued. The path along the upper shrubbery has been lowered and put in order and the path through new lawn gravelled.

A flight of steps and a new path have been made to connect the path along main road to the gate at the end of the Cupressus avenue, and the two borders near the gate have been manured and dug.

Soya Bean seeds received from the Secretary, C. A. S. have been sown in the vegetable plot.

The digging out of weeds from the lawns along the main drive has been continued.

HENARATGODA GARDEN.

(Superintendent's Report.)

This has as usual suffered from the drought and the want of a water supply.

Clearing, rooting out stumps, shading, watering (from a well) were the chief items in progress

SCHOOL GARDEN WORK IN CEYLON.

(Extracts from Bi-monthly Report of the Superintendent of School Gardens. March–April 1919.)

SCHOOL GARDENS.

The following were the School Gardens inspected by the Superintendent during the period under review :—(1) Bomiriya, (2) Aturugiriya, (3) Alawatugoda, (4) Hanwella, (5) Padukka,(6) Pinnawala, (7) Kesbewa, (8) Maligakande, (9) Hettipola, (10) Biyagama, (11) Akurana, (12) Bandarakoswatta, (13) Tenna, (14) Training College, (15) Methodist College. Of these Nos. 1-3 were good, Nos. 4-11 were fair and No. 12 and 13 were bad.

MR. ALEX. PERERA reports as follows : "The following School Gardens were inspected, i.e., Palugama, Medawela, Balagala, Welimada, Wangiyakumbura, Kumbalwella, Dickwella, Passara and Bibilegama in Uva ; Eravur, Arasadi Training School, Kattankudi, St. Cecilia's, Maruthamunai, Saintha-marithu, Karativu, Sammanturai, Nindoor, Attalachchenai, Irakkamam, Karukoditivu (Akkarai Pattu,) Panankudu, Thambalaville, Komari, Pothuvil and Magilur."

MR. D. D. FERNANDO reports as follows :—"The following School gardens were inspected during the period under review i.e., Tihagoda, Puhulwella, Denagama, Deiyandara, Bamunugama, Narandeniya, C. S. G., Owitigamuwa, Karagoda, Uyangoda, Aturaliya, Dampella, Telijjawela, Paraduwa, Bopagoda, Maliduwa, Poramba, G. V. S., Marambe, Morawaka, Alapaladeniya and Kotapola C. S. G. Of these Kotapola and Narandeniya were in very good condition, while a many of these were in bad order."

MR. C. WICKREMARATNE reports as follows :—"The schools visited during March were : Kelegama, Maiyawa, Medagama, Nattandiya, Walahapitiya, Paluwelgala, Kirimetiyana, Kirimetiyana G. V. S., Potuwatawana, Wadakada, Etiyawela, Etiyawala, G. V. S. and Maligakande. Of these Nattandiya, Walahapitiya and Maligakande were in very good condition. Medagama, Potuwatawana and Kirimetiyana were good. Kelegama and Etiyawala were fair. The former is a promising one as the prospects are favourable. It is almost out of crops at present. Maiyawa is in charge of a trained student and is receiving attention. Paluwelgala has no garden. It has been proposed to acquire a new and better site for the school. I inspected the site and found it to be satisfactory. Kirimetiyana G. V. S. is satisfactorily progressing. Etiyawela G. V. S. has hardly any room for gardening owing to which a poor attempt has been made under the circumstances."

MR. L. DE Z. JAYATILLEKE reports as follows :—"I was appointed Inspector of School Gardens from the 1st of March, 1919. The School Gardens inspected by me during March were : Horawapotana, Kapugollewa, Kahatagahadigiliya, Konwewa, Tammennawa, Eppawala, Moragaswewa, Minneriya, Topawewa and Galkiriyagama. Of these Topawewa garden was very good. Konwewa and Galkiriyagama gardens were good. The rest of the gardens were fair. Mahaelagamuwa was not visited as it had been closed owing to fever epidemic. No inspections were done in April as this was a vacation period.

GOVERNMENT STOCK GARDEN.

Foreman reports as follows :—"Six varieties of brinjal plants were planted in a plot and *keppetiya* leaf manure was supplied. Prepared the land along the Oya and a yam plot was established. The whole place was supplied with a leaf mulch and supporters were made for the creepers. Prepared a plot of raised beds and planted a quantity of Sealy's sweet potato. A nursery each of Johore Jak, Ziziphus jujuba and sapodilla seeds was

formed. Some beds were made along the bank of the river and planted with ginger, turmeric, kuku-lala, and other yams. The ginger and turmeric beds were mulched with paddy husk. Some holes were prepared and fruit plants planted in some of them. A nursery of 19 varieties of palm seeds was formed. The dadap trees are being pruned to provide more light and air to the cacao plot. In addition to the above, the whole garden was several times weeded, and drains and roads were cleared."

THE CONSERVATION OF OUR CEREAL RESERVES.

The dangers to which grain stored under ordinary conditions is exposed may be classified under four heads: (1) The attacks of rats and mice; (2) those of insects and mites, (3) those of moulds and bacteria; and (4) the process known as "heating." The amount of damage due to rats and mice is, no doubt, enormous, but might be avoided by any rational system of storage, and is a matter for legislation rather than for scientific investigation. The chief insect pests in this country are the two grain-weevils: *Calandra granaria* and *C. oryzae*; while in India two other beetles: *Rhizopertha dominica* and *Trogoderma khapra*, are also responsible for much direct injury. Experiments on the rate of multiplication of the weevils show that at suitable temperatures they breed all the year round, but in this country normally only in the warmer months. At about 28°C. a single pair of rice-weevils increased about seven-hundredfold in four months. The accumulated excrement of the weevils attracts moisture and promotes decomposition, accompanied by the evolution of large quantities of ammonia, and in this way the destruction, commenced by the ravages of the insects is completed. The process of heating is the result of enzymic action in the wheat itself, sometimes inaccurately spoken of as respiration, though fermentation would be a better term, which increases with rise of temperature (up to about 55°C.) and moisture content (Bailey & Gurjar). In the eyes of the trade, heating appears to be a much more serious danger than weevilling. It is at present avoided by abundant ventilation, the grain being turned over as soon as the temperature becomes dangerously high, so as to cool it and carry off moisture.

As an effectual means of preventing damage from all these sources, airtight storage should be resorted to. Unfortunately, however, considerable doubt has been thrown on the efficacy of this ancient method by a widespread belief in the ability of weevils to withstand such treatment. This belief rests entirely upon inaccurate observations. Thus we find that tins which are supposed to be hermetically sealed, and look perfectly sound, are often leaky, as can easily be shown by placing them in hot water, when air bubbles out. Numerous experiments made at King's College by PROF. ARTHUR DENDY, F.R.S., and his colleague, MR. H. D. ELKINGTON, who is responsible more specially for the chemical analyses, prove conclusively that all insects present are more or less rapidly destroyed, when weevilly wheat is sealed up in airtight receptacles which it nearly fills. This method of treatment destroys the weevils in all their stages, and is also fatal at any rate to adult mites. The same treatment also prevents the growth of moulds and the process of heating. Two Dewar flasks, filled with grain having a moisture content of

20·7 per cent., were incubated at about 28 °C. One was merely plugged with cotton-wool and the other hermetically sealed. In the former, the temperature gradually rose to 49·4° C., while in the latter it remained almost stationary. The life of insects and moulds and the process of heating alike depend upon the supply of oxygen and where this is cut off, no damage from these sources need be feared.

It has been demonstrated experimentally, not only that weevils require an abundant supply of oxygen, but also that carbon dioxide, if present in sufficient quantity, has a directly poisonous action upon them. In pure, moist carbon dioxide, they become motionless in three minutes, and can remain in this condition for as much as four days (at room temperature) without losing the power of recovery. A mixture of carbon dioxide with 20 per cent. of oxygen is far more fatal than pure carbon dioxide. This is probably because, in the absence of oxygen, their metabolism is more or less completely suspended, so that the carbon dioxide is unable to exercise its poisonous effect. In a mixture of 56·4 per cent., nitrogen 20·36 per cent., oxygen, and 23·22 per cent. carbon dioxide, weevils became motionless in forty-three hours (at about 30 °C.), and after ninety-one hours' exposure, though 19·09 per cent. of oxygen still remained, none revived when supplied with ordinary air.

When wheat is sealed up in a normal atmosphere, carbon dioxide accumulates naturally owing to the so-called respiration of the grain, the rate of accumulation depending upon temperature and moisture conditions. At ordinary room temperature (July to October) in three months 300 grams of English wheat, having a natural moisture-content of 15·9 per cent., gave off 58·6 milligrams of carbon dioxide, sufficient to raise the percentage of that gas in the air in the receptacle (which was nearly filled with wheat) to 18·13. If insects also be present, the carbon dioxide accumulates more rapidly owing to the large amount which they themselves give off. It thus appears that in hermetically-sealed granaries completely filled with grain there should be no need for any artificial addition of carbon dioxide such as has sometimes been recommended, and, indeed, actually made, for the purpose of destroying weevils. Under proper conditions, which ought to be experimentally determined on a large scale, the grain must become self-protective as regards weevilling, mildew, and heating, to say nothing of rats and mice. Any damage which might arise while the carbon dioxide was accumulating, would probably be negligible.

The construction of airtight granaries or silos is a problem for the engineer, but there seems to be no insuperable difficulty in the way. If such granaries existed in the large wheat-growing countries, the grain might be completely sterilised as regards insect-life by storing for a suitable period before shipment, and the very serious weevilling which often takes place on board ship might be avoided. Moreover, it would be possible to equalise shipments all the year round and avoid the rush to get the grain away after harvest. Airtight storage would also, in all probability, afford by far the best means of maintaining reserves of grain to meet emergencies such as war and failure of crops.

Further details have been, and will be, published in the report of the Grain Pests (War) Committee of the Royal Society, under the auspices of which these investigations have been carried out.—NATURE, No. 2,577, Vol., 103.

THE PRODUCTION OF PLANT ESSENCES IN THE DUTCH EAST INDIES.

The resumption on a large scale, after the war, of the manufacture of scented soap and perfumes, will make the production of plant essences very important. The plants that produce these essential oils in the Dutch East Indies are wild or cultivated.

Among the wild species may be mentioned the "cajuput" from which is obtained cajuput oil by distilling the leaves. Adulteration with paraffin, benzine, etc., is all the more common as it is not easily detected; adulteration may, however, be detected by violently shaking a bottle half filled with the oil; the air bubbles produced vanish at once in the pure liquid, remaining, however, for some time in the adulterated product. The green colour of the oil is due to the presence of copper and chlorophyll compounds; this is why a small piece of copper is often added to the product. Cajuput oil is much used in therapeutics. It is mostly exported to Singapore, the chief market of the product for British India. It is also sent to the United States where it is used in making a number of proprietary pharmaceutical products. Good quantities are also bought by Siam, Hongkong and Timor Island; in Europe, the chief buyers are Great Britain, Holland and Germany. In 1913, 1914 and 1915 the total exports were 124,228, 65,469 and 79,863 kg. At present there is a tendency for eucalyptus oil to replace this product.

The species cultivated occupy an area of about 3,000 hectares, 2,700 of which are in Java alone. They are often found with other crops on large estates. The chief essential oils furnished by these species are given below:

Citronella oil is obtained by distilling "serchwangi-grass" a grass mostly cultivated by the natives; 1,000 kg. of the grass yield about 7 kg. of the oil, which is mostly used in soap and perfume making (synthetic essence of roses). The chief producing countries are Ceylon and Java; Java produces by far the smaller quantity, but the product is of better quality and fetches twice the price of the other. The exportation of Javanese citronella oil to all countries was:—1913, 75,230 kg.; 1914, 136,654 kg.; 1915, 234,326 kg.; 1916, 428,743 kg.; 1917, 515,763 kg. The largest importers are the United Kingdom, the United States and Japan.

Lemon-grass Oil.—Produced from the grass of the same name, the yield being 0·2 per cent. Importers prefer the oil from Cochin China and Reunion.

Cananga Oil.—Obtained by distilling the fresh flowers of the cananga, a tree that usually flowers twice a year, giving 60 kg. of flowers; to obtain 1 kg. of oil requires at least 350 kg. of flowers. This product is exported in small quantities; not mentioned in official statistics; it has to compete with ylang-ylang oil from the Philippines, which costs 10 times as much.

Champaca Oil is obtained by distilling the flowers of two *Magnoliaceae* common in India; the oil-yield of the flowers is about 0·2 per cent.

Vetiver Oil is obtained from the roots of the vetiver or cuscus grass; the roots contain from 0·4 to 0·9 per cent. of essential oil; no official statistics as to its exportation are available.

Patchouly Oil is obtained by distilling the stems and leaves of *Pogostemon Patchouly* Pell. The leaves can be gathered repeatedly, at intervals of 6 months. The east coast of Sumatra furnishes most of the supply.

Geranium Oil is obtained by distilling the leaves of *Pelargonium* spp., the essential oil of which much resembles that of the rose. It is widely cultivated, especially in rubber plantations. During some researches it was found that 71 plants gave 76·5 kg. of leaves, which produces 53 cc. of essential oil containing as much as 58·8 per cent. of geraniol.—BULL. INTERNAT. INST. OF AGRIC., Year IX, No. 12.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MAY, 1919.

Province, &c.	Disease.	No. of cases up to date since Jan. 1st, 1919.	Fresh cases	Recoveries.	Deaths.	Balance Ill.	No. Shot.
Western	Rinderpest	445	106	68	342	13	22
	Foot-and-mouth disease	217	—	217	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	2	—	—	2	—	—
Colombo Municipality	Rinderpest	258	23	—	—	—	—
	Foot-and-mouth disease	8	—	—	—	—	—
	Anthrax	13	—	—	—	—	—
	Rabies	19	—	—	—	—	—
Cattle Quarantine Station	Rinderpest	33	2	—	—	—	—
	Foot-and-mouth disease	10	10	—	—	—	—
	Anthrax	209	52	—	—	—	—
Central	Rinderpest	158	32	19	130	9	—
	Foot-and-mouth disease	59	—	49	7	3	—
	Anthrax	6	—	—	6	—	—
	Rabies	11	—	—	11	—	—
Southern	Rinderpest	10	—	3	7	—	—
	Foot-and-mouth disease	1996	1850	1456	18	522	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	74	20	26	46	2	—
	Foot-and-mouth disease	580	—	416	35	129	—
	Anthrax	62	62	—	62	—	—
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	802	108	660	123	19	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	108	82	11	94	3	—
	Foot-and-mouth disease	374	—	323	44	6	1
	Anthrax	—	—	—	—	—	—
	Rabies	1	—	—	1	—	—
North-Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	852	—	838	14	—	—
	Anthrax	—	—	—	—	—	—
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	2690	415	2566	27	97	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	211	82	16	162	—	33
	Foot-and-mouth disease	197	93	184	—	13	—
	Anthrax	—	—	—	—	—	—
	Rabies	1	—	—	1	—	—

Colombo, June 4th, 1919.

G. W. STURGESS, G.V.S.

METEOROLOGICAL.

MAY, 1919.

Station	Temperature: Mean Daily Shade	Temperature: Difference from average	Mean Humidity	Mean amount of clouds 0=clear, 10=Overcast	Mean Wind direction during month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	82·2	- 0·3	82	7·9	SW	122	20·01	24	+7·50
Puttalam	83·1	- 0·1	82	6·0	SSW	185	6·85	12	+3·52
Mannar	86·2	+ 0·4	74	7·4	SSW	163	2·28	3	+ 0·15
Jaffna	85·8	+ 0·6	76	5·1	SSW	293	2·08	4	+ 0·23
Trincomalee	87·0	+ 0·8	*	*	*	*	6·04	4	+4·76
Batticaloa	85·2	+ 0·6	72	4·6	ESE	95	2·30	8	+ 0·59
Hambantota	83·5	+ 1·4	78	6·0	WSW	286	1·03	8	- 2·20
Galle	81·8	- 0·1	83	7·8	WNW	236	7·05	22	- 4·46
Ratnapura	81·4	- 0·4	82	7·4	—	—	26·40	26	+8·38
Anu'pura	83·0	- 0·5	76	7·0	—	—	2·04	9	- 1·48
Kurunegala	82·0	- 0·8	76	8·5	—	—	10·80	21	+4·43
Kandy	78·3	- 0·3	78	8·6	—	—	10·04	22	+4·45
Badulla	75·9	÷ 0·1	80	7·2	—	—	7·08	16	+2·55
Diyatalawa	70·6	0	74	7·4	—	—	4·23	15	- 0·67
Hakgala	63·2	- 0·5	84	7·9	—	—	11·85	24	+4·94
N. Eliya	62·2	+ 0·5	86	9·0	—	—	11·42	25	+4·65

* Return not received

From the distribution of Air Pressure over the Island, the South-West Monsoon current arrived on the 15th. Its approach was gradual and its arrival not marked by any great intensity of wind or rain.

For the greater part of the Island, the rainfall was above the average. The greatest excess over the average being to the immediate West of the Hills—in the Kelani Valley. In the Southern Province, the rainfall was in deficit. The number of days on which rain was experienced was greater than usual.

Humidity was above normal Upcountry, and below elsewhere; being especially low to the North and East.

The sky was clouded to an extent greater than usual, especially inland and Upcountry.

On the whole, the temperature was normal.

Wind strength was about normal: but in direction varied by blowing from a point or two nearer the South than usual

Air pressure was slightly above normal.

J. E. EVANS,
Acting Supdt., Colombo Observatory